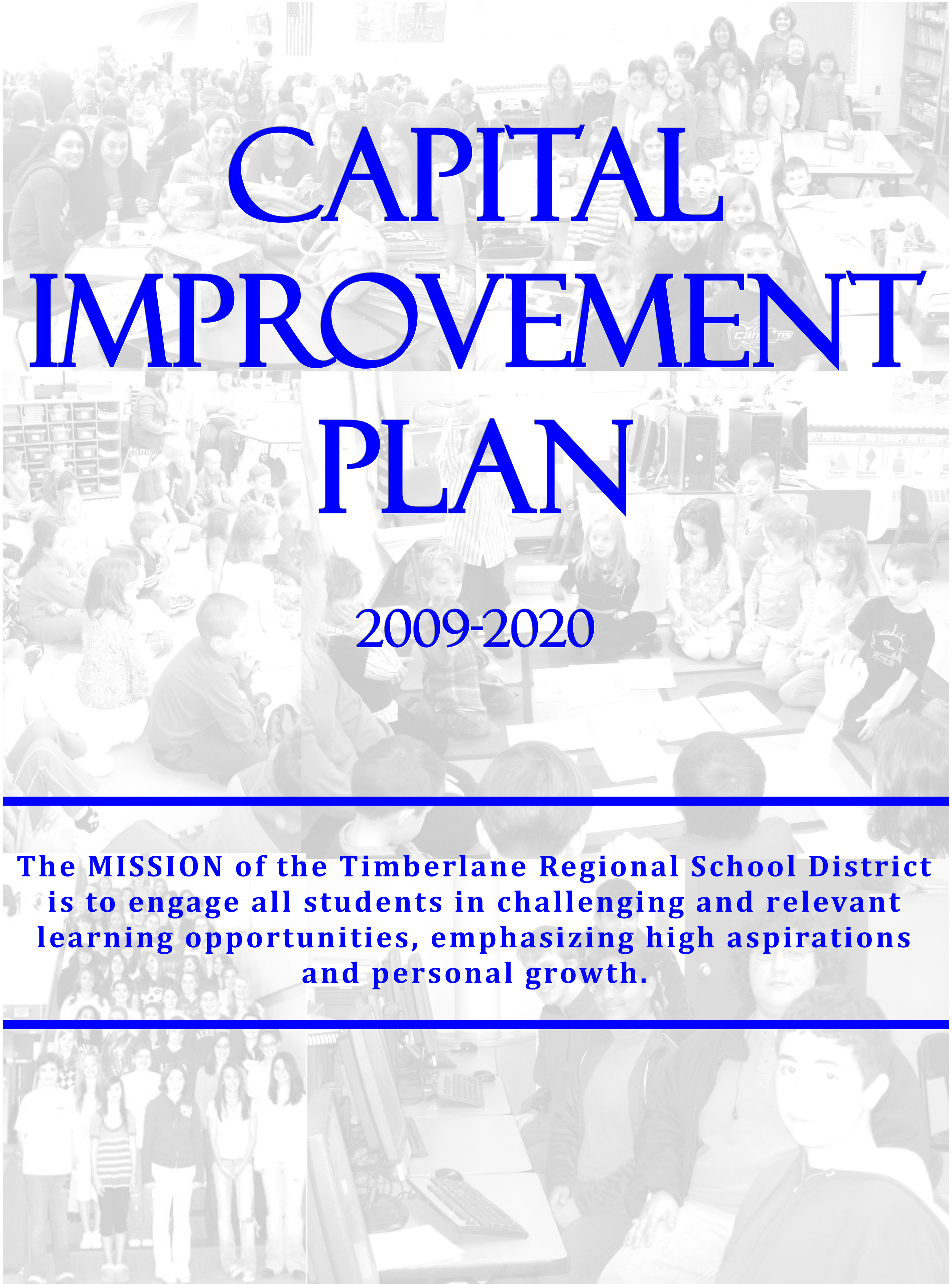
TIMBERLANE REGIONAL SCHOOL DISTRICT



CAPITAL IMPROVEMENT PLAN

2009-2020

The MISSION of the Timberlane Regional School District is to engage all students in challenging and relevant learning opportunities, emphasizing high aspirations and personal growth.

2009-2020 CAPITAL IMPROVEMENT PLAN

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The MISSION of the Timberlane Regional School District is to engage all students in challenging and relevant learning opportunities, emphasizing high aspirations and personal growth.

CAPITAL IMPROVEMENT PLAN

Timberlane Regional School District

WHAT IS A CIP?

The Capital Improvement Plan (CIP) forecasts the District's capital needs over a 10+ year period based on various District-adopted long-range plans, goals and policies consistent with the "Strategic Plan." The underlying strategy of the CIP is to plan for land acquisition, construction, and major maintenance of public facilities necessary for safe, efficient and effective provisions of educational services for the towns of Atkinson, Danville, Plaistow and Sandown. A critical element of a balanced CIP is the provision of funds to preserve or enhance existing facilities and provide new assets that will support quality education in the 21st century.

NEEDS

- ✓ **Renovation** – *facilities improvement, upgrades or additions qualifying for State Construction Aid.*
- ✓ **Reconstruction** – *substantial improvements, upgrades or additions exceeding State ordinary allowances.*
- ✓ **Replacement and New Construction** – *construction of new facility and demolition or repurposing of existing building.*

CHANGING PARADIGMS

EDUCATION THEN	EDUCATION NOW
Top Down Management	Professional Learning Communities
Teachers are Center of Focus	Teacher as Coach
Direct Instruction	Group Learning
Passive Learning	Active/Hands-on Learning
Large Class Size	Smaller Class Size
Control Environment	Engagement Environment
Scheduled Use of Space and Time	Flexible Use of Space and Time
Paper and Text	Technology Rich
Restricted Environments	Fully Inclusionary Environments

"The problem with new challenge is that schools are still organized around the old factory model."

(p.3) The Fifth Discipline

JUSTIFICATION

A **CIP** provides many benefits including:

- Allows for a systemic evaluation of all potential projects at the same time.
- The ability to stabilize debt and consolidate projects to reduce borrowing costs.
- Serves as a public relations and economic development tool.
- A focus on preserving a governmental entity's infrastructure while ensuring efficient use of public funds.
- An opportunity to foster cooperation among departments and an ability to inform other units of government of the entity's priorities.

From Wikipedia

ACKNOWLEDGEMENTS

New England School Development Council (NESDEC)
New England Association of Schools and Colleges (NEASC)
Lavallee Brensinger Architects
Timberlane Strategic Planning Committee
Community Members at Large

FLOW CHART OF PROJECTS

2009-2011
SANDOWN SCHOOLS
10 year bond

2012-2014
MIDDLE SCHOOL
20 year bond

2016-2019
HIGH SCHOOL
20 year bond

2020-2024
REMAINING SCHOOLS

SANDOWN SCHOOLS

Consolidation of the Sandown Elementary Schools that will include a 20,000 sf addition to Sandown North to provide a more cohesive education while implementing a cost savings in the operation of just one building.
Estimated cost: $5,674,000

MIDDLE SCHOOL

Construct a new 203,700 sf free-standing school on the existing high school and middle school property that will include improvements to vehicular ways, athletic areas and pedestrian routes.
Estimated cost: $36,000,000

HIGH SCHOOL

Renovate and reconstruct existing high school facility that will include renovations of 48,000 sf of existing high school, demolition of portions, and construction of an additional 185,000 sf of educational space.
Estimated cost: $37-$40,000,000

REMAINING SCHOOLS

Pollard School, Danville Elementary, Atkinson Academy and the Superintendent's Office needs will be determined at a later date. There are no costs associated with these projects at this time.

FINANCIAL STATEMENT

Estimated costs are provided for preliminary purposes only and reflect the 2009 construction dollars as calculated by New Hampshire Department of Education methodology, and must be modified to reflect typical inflation of construction costs. Over the past several years, costs in New Hampshire have risen by an average of 7% per year.

Project Sequence #1: Sandown Elementary Schools Consolidation.

Project Summary: The proposed solution for the Sandown Elementary Schools is a consolidation of the Sandown North and Sandown Central Elementary Schools on the existing Sandown North Site. The project will include an addition to the existing Sandown School of approximately 20,000 sf of education space, limited renovation of the existing facility to remedy current space shortages and address 21st century education planning principals, installation of a sprinkler system throughout the existing and new facility, and site improvements to address current needs and site shortcomings.

Plan Benefits: The proposed consolidation will allow the Sandown Primary Schools to provide a more cohesive education for it's students. It will place all programs currently spread across two schools into one location, allowing for better coordination between faculty and students across all grade levels.

The teaching spaces will be much improved over those currently offered at Sandown Central Elementary. The classrooms will be adequately sized with optimum daylighting, improved air quality, and designed to support current teaching strategies. The education areas in Sandown North School will be further enhanced by creating proper support spaces to allow integration of programs such as special education, reading programs, and math coordination. Faculty and staff will have spaces for planning, coordination and meeting areas.

The conceptual designs also address site access and safety issues. The final design provides improved vehicular circulation and parking. Students shall have safe access to outdoor areas, like the playground and outdoor athletic space, without crossing vehicular accessways.

Order of Magnitude: The estimated construction costs for the Sandown Elementary Schools Consolidation Project is $5, 674,000. This early phase estimate, including hard construction costs of the building and site improvements, was produced by a Construction Manager based on the current drawings and designs. Hard construction costs for the building can be defined as the cost of the physical building from the foundation upwards including all permanent building systems. The costs of land, utility connections, planning, design and engineering, legal and administrative fees, furniture, fixtures, and other equipment which are not part of a building system are not included. This cost is provided as an order of magnitude and is subject to development as scope of the project is better defined. Particular items like interior finishes, technology infrastructure, and preferred mechanical systems can have significant impact on the construction costs of a project. Also note that the estimate provided is set in current (2009) construction dollars, and must be modified to reflect typical inflation of construction costs. Over the past several years, construction costs in New Hampshire have risen by an average of 7% per year; therefore, the project timeline for construction approved by voters can weigh heavily into the construction costs for any project.

"Soft Costs" can also have significant effects on the total amount of a project's cost. Soft costs include a wide array of items which all contribute to a total school bond required to construct or renovate a building. These costs include (but are not limited to): engineering and design fees, legal and administrative fees, furnishing and equipment not part of the building systems, utility connection charges, and permitting fees. Soft costs can vary from school to school depending on local requirements and also on the amount of furnishings, equipment, and technology suitable for re-use in a new or rehabilitated school. In general, these costs can range from 20-30% of construction costs.

Project Sequence #2: Timberlane Regional Middle School.

Project Summary: The proposed solution for the Timberlane Regional Middle School is a new 203,700 sf free-standing School on the existing High School and Middle School property. It includes site improvements to vehicular ways, athletics areas, and pedestrian routes. The current plan recommends an additional access be purchased / provided to improve vehicular flow.

Plan Benefits: The proposed design provides spaces to accommodate implementation of a 21st century education. Classrooms and labs will be adequately sized and provide environments with good indoor air quality and ample natural light proven to be crucial to progressive learning. The school will provide a secure environment in accordance with modern safe schools design initiatives. The facility will be fully accessible and compliant with all applicable fire and safety codes. The building itself will be designed to exceed the energy code and minimize environmental impacts as a High Performance school in accordance with the guidelines of the NH Collaborative for High Performance Schools. Overall the facility will remedy issues noted in the existing facility assessments provided by Lavallee Brensinger Architects and deficiencies noted by the report from the New England School Development Council. It will accommodate the current and programmed capacity for the Middle School (currently set at 1100 students). It will embrace the Middle School Philosophy set forth by the Educational Specification and the goals of the District and the greater community.

Order of Magnitude: The estimated order of magnitude for construction costs for a new Timberlane Regional Middle School is between 33 and 38 Million dollars. This is based on Lavallee Brensinger's project experience and on the average school construction costs in NH for2008 of $175 per square foot, as reported by the New Hampshire Department of Education. The estimate provided is set in current (2009) construction dollars, and must be modified to reflect typical inflation of construction costs, estimated at 7% per year. This figure includes hard construction costs for the building only. Hard construction costs for the building can be defined as the cost of the physical building from the foundation upwards including all permanent building systems. The costs of land, site work, utility connections, planning, design and engineering, legal and administrative fees, furniture, fixtures, and other equipment which are not part of a building system are not included. Site construction costs are difficult to estimate until a clear scope has been defined and a thorough site investigation (including geotechnical reports and site surveys) has been completed. These costs are primarily based on the existing site make-up and final site design. As noted above, a new Middle School project would benefit greatly from a second access point from East Road. The actual access point acquired could have a significant effect on site planning for the project. Also note that the improvements made to the existing Middle School site can vary greatly themselves, from asphalt parking and basic lawn-type athletic fields to fully irrigated and under-drained athletic fields, or even lighted artificial turf fields.   All of these options should be considered further as part of a Middle School capital improvements project.

"Soft Costs" can also have significant effects on the total amount of a project's cost. Soft costs include a wide array of items which all contribute to a total school bond required to construct or renovate a building. These costs include (but are not limited to): engineering and design fees, legal and administrative fees, furnishing and equipment not part of the building systems, utility connection charges, and permitting fees. Soft costs can vary depending on local requirements and also on the amount of furnishings and equipment suitable for re-use in a new or rehabilitated school. In general, these costs can range from 20-30% of construction costs.

Project Sequence #3: Timberlane Regional High School.

Project Summary: The proposed solution for Timberlane Regional High School is a reconstruction and renovation of the existing High School Facility in its current location. It includes renovation of 48,000 sf of the existing High School, demolition of portions of the remaining High School, and construction / reconstruction of an additional 185,000 sf of educational space, totaling a 233,000 sf modern high school facility.

Plan Benefits: The design will provide a modern High School Facility, fully accessible and code compliant, and design to accommodate the current and future curriculum for a planned enrollment of 1500 students. It will remedy all deficiencies listed within both Lavallee Brensinger Architect's Existing Facility Assessment and the report provided by the New England School Development Council. As part of this, it will address current over-crowding issues, inadequate classroom sizes, and poor functional layout. The upgraded facility will also have improved energy efficiency and will seek a High Performance accreditation for Renovated / Existing Schools as expected to be available from the NH Department of Education this coming year. The high school will be more secure and more easily supervised as part of safe schools planning initiatives. It will reuse the existing facilities which are in good condition including recently upgraded Science Labs and classrooms, as well as the existing Gymnasium and Cafeteria. Another benefit of renovating the existing high school facility in place is the opportunity to reinforce its connection to the Performing Arts Center. The project shall include upgrades to the Performing Arts Center necessary for the District's music and performing arts programs. The design will also seek to embrace and improve community use of the facility. Overall the project will enable the Timberlane Regional School District to provide a cutting edge high school education.

Order of Magnitude: The estimated order of magnitude for construction costs for a renovated and reconstructed Timberlane Regional High School is between 37 and 40 Million dollars. This is based on average school reconstruction costs and our and our consulting engineer's assessment of the current facility. The estimate provided is set in current (2009) construction dollars, and must be modified to reflect typical inflation of construction costs, estimated at 7% per year. This figure includes hard construction costs for the building only. Hard construction costs for the building can be defined as the cost of the physical building from the foundation upwards including all permanent building systems. The costs of land, site work, utility connections, planning, design and engineering, legal and administrative fees, furniture, fixtures, and other equipment which are not part of a building system are not included. Site construction costs are difficult to estimate until a clear scope has been defined and a thorough site investigation (including geotechnical reports and site surveys) has been completed. These costs are primarily based on the existing site make-up and final site design. Improvements made to the existing High School site will be heavily contingent upon improvements made as part of a New Middle School Project. Once the High School Reconstruction is completed, serious consideration should be given to

"Soft Costs" can also have significant effects on the total amount of a project's cost. Soft costs include a wide array of items which all contribute to a total school bond required to construct or renovate a building. These costs include (but are not limited to): engineering and design fees, legal and administrative fees, furnishing and equipment not part of the building systems, utility connection charges, and permitting fees. Soft costs can vary depending on local requirements and also on the amount of furnishings and equipment suitable for re-use in a new or rehabilitated school. In general, these costs can range from 20-30% of construction costs.

20/40 Capital Improvement Plan

Draft Proposal

Current Capital Assets

- High School
  - Built 1966
  - Renovated 1980, 1987, and 2000
- Middle School
  - Built 1975
  - Renovated 1984, 1996, 2000
- PAC
  - Built 2001
- SAU
  - Built 1987

Capital Assets Continued

- Atkinson Academy
  - Built 1803
  - Renovated 1954, 1975, 1987, 1995, 2000, 2007
- Danville Elementary
  - Built 1963
  - Renovated 1987, 2000, 2001
- Pollard Elementary (Plaistow)
  - Built 1912
  - Renovated 1954, 1987, 1995, 2000
- Sandown Central
  - Built 1954
  - Renovated 1987, 2000, 2001
- Sandown North
  - Built 2001

Statement Of The Problem – NESDEC (pg 54)

- Need to develop a long-range plan for PK-12 facilities and educational program planning
- Need to consider purchase of additional land at the middle school/high school site to expand field space and provide for a second avenue of egress from the school campus
- Need to continue efforts to improve building security
- Need to rehabilitate/replace school spaces which do not support 21st Century educational programs
- Need to increase high school and middle school capacities and address current inadequate instructional spaces

Actions for Capital Improvement

- Identify current and future needs
- Develop strategies that protect current Capital Assets
- Refresh programming to better meet 21^{st} Century educational expectations
- Study and select appropriate responses
- Develop a timeline

The 3 R's of Capital Improvement

- Renovation
  - Facilities improvements, upgrades or additions qualifying for State Construction Aide (+25% of current value).
- Reconstruction
  - Substantial improvements, upgrades or additions exceeding State ordinary allowances (+60% of cost of new construction).
- Replacement and New Construction
  - Construction of new facility and demolition or repurposing of existing building.

Consequences of No CIP

- School Impact
  - Project Backlog
    - Within 10 years every building will require Renovation, Reconstruction, or Replacement
  - Cost prohibitive
    - Projects backlog causing many projects to come due at the same time
    - Improvements done as "deferred maintenance" do not qualify for matching aide
  - Negative impact on education, safety, etc. (NESDEC pg 70)
  - Unmanageable with difficult transition planning
- Community Impact
  - Negative impact on QL and property values (NESDEC pg 71)
  - Negates Community Impact Planning

Potential Capital Improvement Timelines

- “All at the same time” --Previous Capital Improvement effort
  - Results in very large Bond
  - Negates transitional planning
- “One project at a time”
  - Based on 20 year bonding
  - 8 Projects
- 20/40Year Capital Improvement Cycle
  - Base on 20 year bonding
  - 4 staggered bonds

20/40 Year CI -- Cycle 1

- Sandown Consolidation
  - Renovation and Closing
  - March 2009 – Sept. 2011
  - 10Year Bond
- Middle School
  - Replacement
  - March 2012 – Sept. 2014
  - 20Year Bond
- High School
  - Reconstruction
  - March 2016 – September 2019
  - 20Year Bond (Retire 1999 $32Million Bond)
- Pollard, Danville, Atkinson, SAU
  - TBD
  - March 2020 – September 2024
  - 20Year Bond

Benefits of Capital Improvement Plan

- Improved education, safety, efficiency and health
- Minimize deferred maintenance
- Stabilize indebtedness
- Minimize negative budget impact
- Provide District and Community long-range planning
- Protect District Assets
- Access State matching aide

Next Steps

- Recognize need for Capital Improvement Plan
- Build Support
- Explore Options
- Develop Timeline
- Present Capital Improvement Plan

The Beginning

CAPITAL IMPROVEMENT PLAN

SEQUENCE #1

Sandown North/Central
- Renovation
  - March 2009-September 2011
    - 10 Year Bond
      - SMALL ($5,000,000)

SEQUENCE #2

Middle School
- New Construction
  - March 2012-September 2014
    - 20 Year Bond
      - LARGE

SEQUENCE #3

High School
- Reconstruction
  - March 2016-September 2019
    - 20 Year Bond
      - LARGE

SEQUENCE #4

Pollard, Danville, Atkinson, SAU
- TBD
  - March 2020-September 2024
    - 20 Year Bond
      - MEDIUM

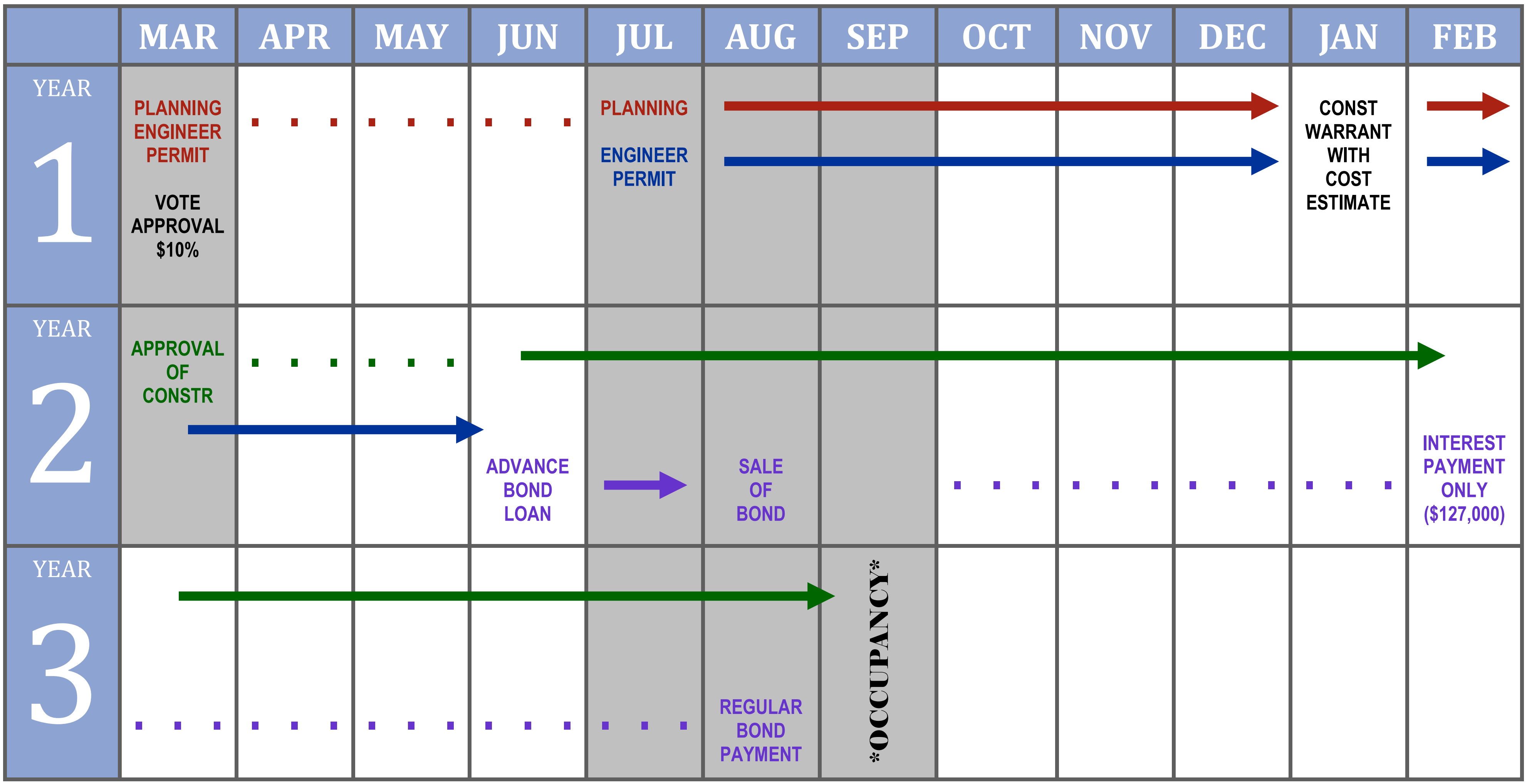
CAPITAL IMPROVEMENT PROJECT LIFE CYCLE

LEGEND

WAITING PERIOD

ACTIVE / IN PROCESS

CRITICAL PERIOD



2009-2020 CAPITAL IMPROVEMENT PLAN

STRATEGIC PLAN

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2009-2015

Timberlane Regional School District STRATEGIC PLAN

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TIMBERLANE REGIONAL SCHOOL DISTRICT

Serving the communities of Atkinson, Danville, Plaistow and Sandown, New Hampshire

30 Greenough Road

Plaistow, NH 03865

(603) 382-6119

www.timberlane.net

DISTRICT ADMINISTRATORS

Richard A. La Salle, Superintendent of Schools

Winfried Feneberg, Assistant Superintendent

George Stokinger, Business Administrator

Kathleen Smith, Assistant Business Administrator

Edwina Lovett, Director of Pupil Personnel Services

Elizabeth Rincon, Assistant Director of Pupil Personnel Services

Kelli Killen, Director of Elementary Education

Charles Coker, Director of Secondary Education

John Holland, Director of Technology

Nancy Danahy, Human Resource Director

Sandra Hodgkins, Director of Transportation

James Hughes, Director of Facilities

DISTRICT SCHOOLS

Atkinson Academy, Atkinson, NH (Grades K-5)

Danville Elementary, Danville, NH (Grades K-5)

Pollard School, Plaistow, NH (Grades P-5)

Sandown North Elementary, Sandown, NH (Grades K-3)

Sandown Central School, Sandown, NH (Grades 4-5)

Timberlane Regional Middle School, Plaistow, NH (Grades 6-8)

Timberlane Regional High School, Plaistow, NH (Grades 9-12)

TIMBERLANE REGIONAL SCHOOL BOARD

Lori Aubrey	Robert Collins	Michael Mascola
William Baldwin	Louis Porcelli	John Paone
Arlene Champey	Elizabeth Kosta	Lisa Withee

Adopted by the Timberlane Regional School Board April 2, 2009.

2009-2015 TIMBERLANE REGIONAL SCHOOL DISTRICT STRATEGIC PLAN

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The Timberlane Regional School District will achieve the best outcome for every student.

INTRODUCTION

The Challenge

In *School and Society*, published more than a century ago, John Dewey set a common sense aim for schools, stating, "What the best and wisest parent wants for his own child, that must the community want for all its children. Any other ideal for our schools is narrow and unlovely; acted upon, it destroys our democracy"[1]. The Timberlane Regional School District embraces the ideal that *all children have equal access to equally good instruction and is dedicated to achieving the best outcome for every student.*

This strategic plan identifies what must be done, pre-school through grade 12, over the next three to five years to achieve significantly higher levels of school effectiveness and student achievement in a safe, comfortable and secure environment.

Award-Winning Schools

Citizens of Atkinson, Danville, Plaistow and Sandown have reasons to be pleased with their schools' accomplishments and awards over the years. A sampling follows. The elementary schools consistently receive the *Blue Ribbon Award for Volunteerism*, Danville Elementary for 20 consecutive years, Sandown Central for the last 19 years, and Pollard Elementary for 18 years. Pollard has also received the Gold Circle Partnership Award for two years that recognizes community partnerships. Individual student inventors receive awards in state-wide *Invention Convention* contests. Teams of elementary, middle and high school students compete successfully in *Destination Imagination* (a creative problem-solving competition) at the state level; some teams advancing to the national finals. Elementary and middle school students place well in competitions as varied as *Spelling Bees, Geography Bees*, and *PTA Reflections Photograph.* Atkinson students have won the Fidelity Stock Market Award two years running, while, in recent years, three teachers (Pollard School and TRMS) were recognized as *Wal-Mart Teacher of the Year.*

The Timberlane Regional High School music program is highly acclaimed throughout the state as evidenced by the extraordinarily high number of TRHS students that participate annually in the *All-State Music Festival*. Timberlane musicals and theater productions, including student-written plays, draw appreciative audiences. Each year, more students take the *College Board AP (Advanced Placement) Exam*, and more scholarship funds are awarded to seniors to continue their education. Over 400 students are chosen to represent all *Honor Societies*. In each of the last three years over 1000 student-athletes participated on *sports teams* and more

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than 350 students joined *school clubs.* TRHS student-athletes have won numerous individual *and team championships at the league, state and New England level*. Several teachers have received commendations by outside organizations for their contributions to teaching and administration. Twenty percent of the graduating class of 2008 took at least one Evening Division course during their years at TRHS, and this program has been cited by the NH Department of Education as one of sixteen programs in *Public School Choice*.

Community Support and Commitment to Improvement

The Timberlane Regional School District (TRSD) would not have award-winning schools were it not for the support of the four communities comprising the district, and a school administration and staff committed to continuous improvement. Many community organizations support and have partnerships with our schools such as the police and fire departments, and libraries. Parents of each town serve on school and district committees and provide numerous hours of volunteer time.

The Atkinson Academy, Danville Elementary, Pollard School, Sandown Central and North, and the regional Middle School and High School are good, but they need to be much better if our students are to have a chance for success in the highly competitive, high skills work place in which their adult lives will play out. The rate of change is accelerating; incremental improvement in an exponential world will no longer work. Our high school graduates will possess high skills for heightened opportunities, or face the stark reality of low skills and limited prospects.

STRATEGIC PLANNING PROCESS

Benefits of Strategic Planning

The strategic planning process takes into account our changing environment and identifies what needs to be done to keep the TRSD locked on mission and effective over the long term. This includes improving the TRSD's standing among public and private schools on such measures as student academic achievement, graduation rates, and graduate success in the workplace and in higher education.

Including key constituent groups in the process --- parents, students, educators, government officials, local business owners, and senior citizens --- increases the likelihood that the right priorities for improvement are identified. Putting these improvement initiatives in the spotlight adds urgency, concerted effort, and transparency to the work. Case in point: TRSD schools and the communities have indeed achieved the goals of the strategic plan adopted a decade ago.

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An important side benefit of the strategic planning process is having hundreds of pages of key documents compiled, catalogued and available in a central location for future reference.

Key Questions

The TRSD strategic planning process began in the fall of 2007 by asking several *key questions,* the answers to which would later form the content of the strategic plan. These key questions, found below, drove the planning process, had no obvious right answers, encouraged serious thought, and allowed the plan to reflect the personality and promise of the TRSD.

The Steering Committee divided the key questions among three teams of educators and community members and charged each team to come up with their best answers:

WHERE WE ARE TODAY? – WHAT IS THE CURRENT STATE OF OUR SCHOOLS?

"What are the current key strengths and areas needing improvement in each school, and in the district as a whole?"

"*What social, cultural, environmental, technological, economic, and political trends and forces present opportunities, or obstacles, for our schools?"*

"Are all our students sufficiently prepared to meet the academic and social challenges they face as they "graduate" from one school to another and from high school to the workforce or college? And for those who are not, what can be done to improve their chances for success?

WHERE DO WE WANT TO BE TOMORROW? – WHAT IS OUR STRATEGY GOING FORWARD?

"What are the top things today's TRHS graduates should know, be able to do, and be like, and what 21st Century trends and developments support these choices?

"What kind of learning community does our school need to become in order to more fully achieve our mission, beliefs and vision?"

"*What do we want the schools comprising the TRSD schools to be widely and well known for? "*

Team 1 examined several studies and reports to better understand and appreciate the school district's needs and recent improvement efforts. In addition, teams conducted surveys of students, parents and educators, and held a well-attended focus group to more fully answer the questions posed in the strategic planning process. The strategic actions recommended in the pages that follow were derived from the studies, reports and surveys listed in the Endnotes section of this report. These source documents will be invaluable to decision-makers going forward.

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Organization of the Report

The wealth of information and recommendations generated by the teams in response to guiding questions was discussed and debated, summarized and prioritized by the steering committee into the following categories:

Trends and Forces…..Implications for TRSD
Mission, Beliefs and Vision
Student Compentencies for the 21st Century
Goals and Strategy

- High Expectations for All Students
- Professional Learning Community
- Technology
- School Facilities

Next Steps in Strategic Planning Process
References
Resources
Strategic Planning Committee and Team Members

TRENDS and FORCES ….. IMPLICATIONS for TRSD

"What social, cultural, environmental, technological, economic, and political trends and forces present opportunities, or obstacles, for our schools?"

The TRSD, is nestled in southern New Hampshire, yet inextricably linked to the larger world. Schools need to get in step with the future. The trends, forces and influences which follow describe the environment in which this strategic plan was developed. Some are beyond the school's ability to influence or control, some present opportunities for TRSD schools to take advantage of, while others present obstacles to overcome. Looking ahead, the next several years seem to be all about the economy, energy, environment and education:

FAMILIES and ECONOMY

An increasing number of families, including many senior citizens on fixed income, face growing financial hardship. The income gap is growing between the rich and the poor, both within and between nations. Currently in 2009, credit markets are tightening. Job layoffs, unemployment, bankruptcies, mortgage foreclosures, and credit card debt are increasing. Inflation and the declining value of pensions and investments cut into available income. Adding to the stress are rising college tuitions, escalating health care costs, and cutbacks in services as governments confront declining revenues. The timeline for economic recovery is uncertain, but could take two to three years.

Implications for TRSD: There is the potential for little or no increase in town and school budgets. State aid to municipalities and school districts continues to decline. Town and school services are scaled back. Churches, civic and social organizations step up efforts to help families in need. Students are more likely to attend post secondary schools closer to home, or postpone plans. More families have both parents working to make ends meet, assuming work can be found, leaving less time to spend with their children. Public school enrollment increases as strained family budgets can no longer afford private school tuition for their children.

NATURE and NATURAL RESOURCES

Stress on the global environment increases as demand for resources by developed countries, and developing countries (especially China and India), grows at an alarming rate, unsustainable in the long run. Climate change portends a potentially calamitous crisis in this century.

Implications for TRSD: Schools, town government, businesses, civic organizations, and the community at large expand conservation efforts ("reduce, reuse, and recycle") to save money and the environment. Local businesses join in the national effort to invent and manufacture alternative energy sources (geothermal, wind, solar, clean coal technology, etc) to lessen demand on fossil fuels.

HEALTH and MEDICINE

Medical advances continue to improve life quality and longevity. The cost of medical care continues to rise faster than the rate of inflation. An increasing number of children are diagnosed with health and handicapping conditions, for example, diabetes, obesity, asthma, and autism.

Implications for TRSD: Schools face an increase in the number of children determined to need special education services, putting added pressure on school budgets. Programs to reduce obesity focus on increasing physical exercise and improving the nutrition of school lunch menus.

TECHNOLOGY

Technological innovation is occurring at an ever-increasing rate. The way we "connect" with information and people is changing dramatically: In the not distant future, computers will be as common in households as toothbrushes. Anyone, of any age, who is not "technology smart", will be at a distinct disadvantage.

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Implications for TRSD: The decreasing per unit cost of technology is offset by the increasing number of units needed to provide every student with sufficient access to technology. Schools become "computer literacy centers" for the entire community.

EDUCATION and COMPETITION

Competition between nations' economic systems, first and foremost, is competition between nations' education systems, and America's public schools are lagging behind. Pressure will grow for alternatives to public schools (charter schools, home schooling, vouchers, on-line education programs, for-profit schools, etc), world class K-12 standards, competency-based high school diplomas, apprenticeship programs connecting school to the world of work, and the development of knowledge, skills, attitudes, and work habits essential for success in a more demanding work and higher education environment. The 21st century graduate will need to work collaboratively in high performance teams, demonstrate creativity, ingenuity, and problem-solving skills, speak and write well (preferably in two languages), be computer savvy, and embrace ethnic and cultural diversity. Growing research and recognition of the importance of pre-school years in a child's development will lend support for quality pre-school programs and family services.

Implications for TRSD: TRSD schools are labeled "failing" as the nearly impossible NCLB requirement that each and every student perform at or above the proficiency level on standardized tests by the year 2014 is unmet. NCLB and high stakes testing concentrate teaching time and resources on a narrow band of curriculum and assessment content, leaving less to prepare students for the full breadth of challenges of life and work in the 21st century. Proposals to change the school schedule, school day or school year are met with voter skepticism, especially if they cost more money. The shortage of teachers and administrators (already a serious problem in many school districts) increases as baby boomers retire and others leave the profession, adding to financial and programmatic strain on school budgets.

Schools are expected to be more productive, to accomplish more with less. Unfunded and partially funded mandates (IDEA, NCLB, Compulsory school attendance to age 18 in NH) add to budget pressures while funding questions continue in New Hampshire years after the NH Supreme Court's landmark Claremont school funding ruling. School funding challenges intensify as school needs compete at all levels of government (local, state, national) against a growing list of priorities including, but not limited to, national security, natural disasters, global warming, prevention of disease pandemics, escalating health care costs, rising fuel costs, nation-wide repair of deteriorating infrastructure, and underwriting the development of alternative energy sources.

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MISSION, BELIEFS and VISION

"We cannot always build the future for our youth,
but we can build our youth for the future."
...Franklin D. Roosevelt

The mission statement answers the question, "What is the purpose of the TRSD Schools? Team 3 examined current trends and looming forces, studied the responses of more than one hundred focus group participants, reviewed existing statements of mission and beliefs and updated them to reflect 21st century demands and expectations.

The **MISSION** of the Timberlane Regional School District is to engage all students in challenging and relevant learning opportunities, emphasizing high aspirations and personal growth.

The statement of TRSD **BELIEFS** answers the question, "What are our deeply held convictions?"

We believe that education for the 21st century includes rigorous and relevant academic, technical and problem-solving skills that prepare students for the next level of education.

We believe that strong instructional leadership and highly qualified personnel work as colleagues to deepen knowledge and improve instructional practice, creating a rich academic environment.

We believe that a learning organization practices the sharing of knowledge, the adoption of new principles, and continuous growth.

We believe effective communication connects parents, teachers, students and the community, fostering trust and interdependence.

We believe that all members of the learning community must promote respect for self, respect for others, and respect for community.

We believe creative expression and the appreciation of the arts are essential to quality of life.

We believe all students can achieve high standards and are entitled to demonstrate their knowledge and skills in ways which recognize their individual abilities, talents, and learning styles.

We believe in modeling democracy by giving voice to all who are directly affected by the school, including students, and addressing all forms of unfairness and injustice.

We believe quality facilities matter.

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> *"Soon after the completion of Disney World, someone said, 'Isn't it too bad Walt Disney didn't live to see this.' I replied, 'He did see it. That's why it's here'"*
>
> *...Mike Vance, Creative Director, Walt Disney Studios*

VISION answers the question, "What will the desired TRSD schools look like? What will be our sources of pride? The best way a school system can attract and retain students, remain the preferred choice among parents, and build community support, is to *distinguish itself in the eyes of students, parents, the community, employers, and higher education.*

The **VISION** of the Timberlane Regional School District states that the Timberlane Regional School District in partnership with the communities of Atkinson, Danville, Plaistow and Sandown will provide resources and programs designed to support students' diverse academic, social, and emotional needs. Effective and dedicated professional educators, administrators and support staff will challenge students with a rigorous curriculum that considers individual learning styles. We will be a school district of excellence that exemplifies best practices in academics, student services, facilities, safety and security. Timberlane graduates will be prepared to assume leadership roles as students in colleges and universities, as professionals in their chosen careers and as citizens in this rapidly changing world.

HIGH EXPECTATIONS FOR ALL STUDENTS

TRSD schools will consistently provide rigorous, relevant, flexible, and engaging learning experiences for all students that are aligned with the mission, beliefs, and essential student competencies.

TRSD schools will lead in environmental education and energy conservation.

All students will achieve the academic standards set forth by the TRSD and the State of New Hampshire.

Student test scores will rank among the top 10 percent in the state.

Students will consistently receive individual and team awards in athletics, academics, and the fine and performing arts.

An increasing percentage of students will participate in sports, clubs, and other school activities.

All students will identify personal interests and pursue them actively and independently.

All students will volunteer service to the school and community.

All students will graduate with high aspirations, skills, and a plan to succeed at the next level.

A steadily increasing percentage of students will qualify for, and attend, post secondary education.

PROFESSIONAL LEARNING COMMUNITIES:

TRSD schools will be staffed by well qualified, talented and committed staff.

TRSD staff members will be recognized as leaders in the development of Professional Learning Communities in their schools.

TRSD will be known for significantly reducing the time it takes to move an innovative idea to full-scale and successful implementation.

All schools continue to be recognized for effective parent-school-community partnerships.

TECHNOLOGY

TRSD staff and students will be recognized for integrating technology throughout curriculum and offering 24/7/365 access to virtual learning opportunities.

SCHOOL FACILITIES

TRSD facilities will adequately support the curriculum, current class size policy, and student enrollment; moreover, facilities will be well-maintained, safe, and comply with all fire, health and safety regulations.

> *"There are two educations.*
> *One should teach us how to make a living and the other how to live."*
> *… John Truslow Adam*

STUDENT COMPETENCIES FOR THE 21ST CENTURY

Global economic, political, social and environmental challenges mount. Knowledge expands exponentially. What 21st century world do we imagine our graduates will be living and working in, and have we *wisely chosen* the most essential learning outcomes to prepare them for that world?

Team 2 was tasked to identify essential high school graduation competencies. Team members examined or created several documents including mission, beliefs and vision statements, the Scholastic Aptitude Test report, the New England Competencies Assessment Program report, advanced placement test results, the Youth Risk Behavior survey, the My Voice Survey,

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community surveys, attendance and discipline data, and the high school's NEASC self-study. Interviews of college admissions officers at each New Hampshire State college provided insight into the qualities and competencies post-secondary schools expect in incoming freshmen classes.

On October 7, 2008, more than 100 citizens from Atkinson, Danville, Plaistow and Sandown met at the high school and weighed in on the question: *"What will our children need to know to be successful in the 21st century?"*

The emerging profile of what the 21st century learner should strive to become --- and our schools must focus on --- follows:

1. ACADEMICS

   1.1 Students demonstrate proficiency in academic and applied subject areas.

   1.2 Students apply what they already know, and can do, to acquire new knowledge and develop new skills.

   1.3 Students discuss and debate issues and events which have local and global significance.

   1.4 Students connect knowledge and experiences from different subject areas and apply multidisciplinary thinking to solve problems (simulated and real) and complete tasks.

2. LIFE-LONG LEARNING

   2.1 Students take responsibility for their own learning and challenge their comfortable limits of thought and performance.

   2.2 Students seek deeper understanding of topics, issues, problems, and questions that interest them. They enjoy learning.

   2.3 Students approach unfamiliar situations with reasoning, adaptability and determination.

   2.4 Students approach learning with an understanding of strategies that work well for them.

   2.5 Students explore career options and pursue post high school plans with an understanding of requirements, confidence, and a strong work ethic.

3. COMMUNICATION

   3.1 Students are proficient readers, writers, researchers, speakers, and listeners.

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3.2 Students express ideas, opinions and information with confidence and clarity, using a variety of communication tools and techniques. Distinguish fact from opinion.

3.3 Students are proficient in more than one language.

4. THINKING AND REASONING

4.1 Students use methods of inquiry and engage in real or simulated investigation characteristic of the academic area or professional discipline; for example, the scientific method.

4.2 Students seek and evaluate various points of view and potential consequences of alternative solutions in debate, discussion, and decision-making.

4.3 Students creatively connect ideas in unconventional ways to construct new insights, solutions, and inventions.

5. TEAMWORK

5.1 Students work effectively and willingly with others in a variety of situations to complete tasks and achieve goals.

5.2 Students manage and evaluate their behavior as group members, recognizing the impact the individual has on the group, and the group on the individual.

6. TECHNOLOGY

6.1 Students use technology tools and software to expedite and enhance information acquisition, quantitative and qualitative analysis, document preparation and presentation.

7. PERSONAL ETHICS

7.1 Students act with honesty, integrity, and a strong sense of fair play.

7.2. Students are courteous and respectful toward others.

7.3. Students take responsibility for their own actions and consequences.

8. LOCAL and GLOBAL CITIZENSHIP

8.1 Students understand and appreciate their own culture and seek to understand the perspectives, values and traditions of other cultures.

8.2 Students recognize mankind's interdependence with nature and seek to make a positive contribution to the lives of others and to protection of the environment.

8.3 Students enhance quality of life by volunteering in their school and community.

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9. FINE and PERFORMING ARTS

    9.1 Students enhance quality of life by engaging in cultural and artistic activities as a spectator and participant.

10. PERSONAL WELLNESS

    10.1 Students make healthy food choices and engage in physical exercise.

    10.2 Students recognize and avoid dangerous involvement with drugs and alcohol.

    10.3 Students access medical and emotional support for themselves and others.

PRIORITY GOALS AND STRATEGY

> *"There is nothing with so much worth as a mind well educated."*
>
> *... Ecclesiasticus*

HIGH EXPECTATIONS FOR ALL STUDENTS focuses on raising the achievement bar *and* closing the achievement gap of all TRSD students. Faced with unprecedented challenges, the 21st century will require the mobilization of every ounce of human intelligence. Perhaps for the first time in history, Wagner observes, "many of the competencies required for work are congruent with some of the more traditional goals of an outstanding liberal arts education: a broad understanding of mathematical and scientific concepts, cultures and peoples; the ability to reason, think critically, and solve problems"[2]. A high school diploma is no longer sufficient. We must prepare our students for college level work.

We are challenged by the May, 2008 Report of the NEASC Visiting Committee for Timberlane Regional High School which states, "There was a recurring theme throughout the visit that there is more tracking of students within the school than is noted in the schedule and in the self-study. Learning opportunities that group students together homogenously do not provide high expectations for all students and thus, actually inhibit student learning for some."[3] In light of the NEASC Report concern about a lack of high expectations for some students, the District should examine ways to improve high expectations for each student.

GOAL #1: Apply Mission, Beliefs and Student Competencies for the 21st Century to **all students***.*

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Strategy:

1.1 By June 2010, create greater school and community awareness of the TRSD mission, beliefs, vision, and 21st century student competencies, and the conditions by which these become "front and center" criteria when adopting and implementing district, school, and classroom policies, procedures and practices.

1.2 By June 2010, Professional Learning Communities (Strategic Goal # 3) review state, local, and district curriculum documents (including the strategic plan) on a district-wide basis, reach consensus on the most *essential* competencies, and downsize/compact the curriculum accordingly.

1.3 By June 2010, align individual school statements with TRSD statements of mission, beliefs, vision, and 21st century student competencies. The goal is a unified, district-wide focus and direction. Individual schools are allowed to supplement, but not supplant, TRSD statements; for example "Owl" at the high school, "Respect, Responsibility, and Right Choices" at the middle school and "STARS" at the Sandown North elementary school.

GOAL #2: Accelerate achievement for all students, across all competencies, and reduce achievement disparities among all groups of students.

Strategy:

2.1 By June 2012, develop and implement programs across all grades and in all classrooms to enrich and accelerate the academic growth and aspirations of all students.

2.2 By June, 2012, evaluate and ensure that all policies and procedures create equal opportunity, high aspirations, high achievement and rigor for all students, K-12.

2.3 By June 2012, provide intensive reading, writing, or math instruction across all grade levels for students in need. Increase instructional time the further a student is away from proficiency.

2.4 By June 2009, convene a representative group of K-12 teachers and administrators to: examine NEASC Visiting Committee Reports for TRHS and TRMS and comparable elementary schools' reports, agree on issues and needs elementary, middle and high have in common, and develop appropriate improvement plans (e.g., Six Traits of Writing, Understanding by Design).

2.5 By June 2014, implement the appropriate recommendations of the May, 2008 Report of the NEASC Visiting Committee for Timberlane Regional High School.

2.6 By June 2014, implement the appropriate recommendations of the forthcoming Report of the NEASC Visiting Committee for Timberlane Regional Middle School.

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> *"Raise hell, constantly question 'the way things are done around here', and never, ever rest on your laurels."*
>
> *...Tom Peters*

PROFESSIONAL LEARNING COMMUNITY focuses on staff members collaborating on a sufficient and sustained basis to improve teaching and learning. Ample research shows that "when teachers engage regularly in authentic 'joint work', focused on explicit, common learning goals, their collaboration pays off richly in the form of higher quality solutions to instructional problems, increased teacher confidence, and, not surprisingly, remarkable gains in achievement"[4].

TRSD staff members universally lament the lack of time to do what they know needs to be done to improve their subject area, their department, their school, and their students' achievement. Best practices cannot spread without peer collaboration in what the TRSD staff calls a "Professional Learning Community". In *The Six Secrets of Change*, Fullan states that "positive, purposeful peer interaction works effectively under three conditions: (1) when the larger values of the organization and those of the individuals and groups mesh; (2) when information and knowledge about effective practices are widely and openly shared; and (3) when monitoring mechanisms are in place to detect and address ineffective actions while also identifying and consolidating effective practices"[5].

GOAL #3: Create scheduled, sufficient, and sustained time for staff members to carry out the work of the school in collaborative Professional Learning Communities.

Strategy:

3.1 By June 2010, all schools will agree on the adoption of a Professional Learning Community model. The Dufour PLC model is recommended. If chosen, schools will be supported in attaining the following milestones: By June 2011, all schools reach the initiation stage, or higher, on all twelve components of a Professional Learning Community; and by June 2013, all schools operate at the sustaining (highest) stage of implementation. Note: Should another PLC model be chosen, other implementation milestones will apply.

3.2 By June 2011, provide training in areas that enhance Professional Learning Community success. This includes training in *people skills* (e.g., leadership, team building, communication, discussion skills, running meetings, resolving conflicts, managing time….) and *technical skills* (e.g., project planning, collection and analysis of data, exploring solutions, taking action, monitoring and evaluating results….)[6].

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"Computers aren't intelligent, they just think they are."

… Anonymous

TECHNOLOGY focuses on the use of technology and telecommunication services to advance learning, improve productivity, and enhance communication between home and school. We are in the midst of a communications revolution. Newer, faster, cheaper, simpler, and smarter technologies come to market every day. Employers and higher education institutions expect their employees and students, respectively, to effectively use computers and related communication devices. Computer technology presents the opportunity to go outside the walls of the school and offer virtual learning experiences to virtually any one, at any time, anywhere, for any purpose, and at any pace.

GOAL #4: All students and staff become proficient users of technology.

Strategy:

4.1 By June 2011, implement K-12 student-use-of-technology outcomes, teaching strategies, and common assessment measures, with the requirement that the entire staff fully participate.

4.2 By June 2011, provide teachers personalized, sufficient, ongoing instruction, and time, to incorporate technology "best practices" into classroom subjects and support student efforts using technology.

4.3 By June 2010, offer and/or expand options for students wishing to access distance learning for remediation, enrichment or acceleration, for high school or college credit; as examples, NovaNet [7], the Virtual (On-Line) Learning Academy Charter School[8] in Exeter, NH., and the Renzulli Learning System/Learning Differentiation Engine[9], based on the School-wide Enrichment Model. Also offer and/or expand project-based experiences for students that are academically rigorous, relevant, and build relationships with adults in the community[10].

4.4 By June 2011, adopt an Information and Communications Technology (ICT) literacy program[11] in grades K – 12 that provides students the opportunity to become proficient in the use of technology within the context of the core subject areas, and to demonstrate ICT competency by the end of 8th grade using assessment rubrics applied to the contents of student digital portfolios.

GOAL #5: Use technology to enhance communication between educators and parents.

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Strategy:

5.1: By June 2009, discuss and decide on new and/or improved school on-line resources/services that could be accessed from home.

5.2: By June 2010, offer adult education courses in technology.

GOAL #6: Determine the total cost for procurement, utilization, and disposal of technology to carry out district-wide and school technology plans.

Strategy:

6.1 By June 2010, establish hardware and software standards for delivering technology and telecommunications service to satisfy academic (classroom) and administrative (office) computing and communication requirements.

6.2 By June 2009, develop a three-year technology and telecommunications plan, and budget, to meet the above-stated strategic goals. Identify and apply for external funding sources.

> *"Form ever follows function."*
>
> *...Louis Henry Sullivan*

SCHOOL FACILITIES focuses on providing classroom and other spaces that are safe, secure, comfortable, and have sufficient capacity to house staff, students, curriculum, programs and services.

Four recent reports provide ample evidence of the need to seriously consider repairs, renovations and additions to the TRHS and TRMS, or new school construction. These reports include: (1) The November, 2008 Long-Range School Facilities Planning Report for the Timberlane Regional School District prepared by the New England School Development Council (NESDEC); (2) The October, 2008 Assessment of Existing Conditions at TRHS and TRMS prepared by LaVallee/ Brensinger, Architects (L/BPA); (3) The May, 2008 Report of the NEASC Visiting Committee for TRHS; and (4) The November, 2008 Self-Study Report prepared by TRMS staff and community as part of the NEASC school accreditation process.

These independent studies, cited above, conclude that the high school and middle school are overcrowded, need major structural upgrades, and are unable to fully meet 21st Century instructional needs.

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The NESDEC Team prepared demography and enrollment projections, visited the schools, consulted with school and community leaders, identified near-term and long-term needs and suggested three alternative solutions and criteria for evaluation[12].

NEAR-TERM NEEDS

The need to develop a long range plan for PK-12 facilities and educational program planning.

The need to consider purchase of additional land at the middle school/high school site to expand field space and provide for a second avenue of egress from the school campus.

The need to continue efforts to improve building security.

LONG-TERM NEEDS

The need to rehabilitate/replace school spaces which do not support 21st Century educational programs.

The need to increase high school, middle school, and elementary schools' capacities and address current inadequate instructional spaces.

The LaVallee/Brensinger Architects Team evaluated the condition of the middle school building and concludes that many of the deficiencies are not addressable at reasonable cost via a renovation of, or addition to, the building. The Team finds a high school building in need of significant improvements and additions to be supportive of the student population and a 21st Century high school curriculum [13].

The NEASC Visiting Committee Report on the high school[14], and the NEASC Self-Evaluation Report [15] prepared by middle school staff and community members, reinforces building inadequacies and concerns identified by NESDEC and L/BPA .

GOAL #7: Develop capital improvement plan and implementation sequence and timetable for the TRSD that addresses the concerns cited in several recent evaluation reports.

Strategy:

7.1 By June 2009, present to the school board viable options to address the identified educational and space needs.

7.2 By June 2009, develop a long-term capital improvement plan for the TRSD and identify a sequence/timetable of priorities to be addressed by the plan.

7.3 By June 2009, identify appropriate architectural design options.

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7.4 By June 2010, create necessary public support for the implementation of the capital improvement plan, including funding of identified priorities.

7.5 By June 2013, demonstrate consistent adherence to the implementation schedule of the capital improvement plan.

> *"What gets measured gets done, what gets measured and fed back gets done well, what gets rewarded gets repeated"*
>
> *... John E. Jones*

NEXT STEPS: IMPLEMENTING the STRATEGIC PLAN

(Based on *Planning for Change: A Source Book for Strategic Planning,* LEADership Center, University of New Hampshire, Durham, NH, 1993).

1. Steering Committee presents Strategic Plan to school board, staff and community for review and comment.

2. Steering Committee considers staff and community comments and approves Strategic Plan.

3. Steering Committee submits final Strategic Plan to the school board for approval.

4. School Board, following approval, authorizes wide distribution of the Strategic Plan to the community and schools.

5. Steering Committee and school administration establish "Actions Teams" to accomplish the work outlined in the Strategic Plan for each priority area.

6. Teams present action plans for review and approval. Decide which action plans require school board approval before being implemented.

7. Action Teams are provided financial support and resources appropriate to the task of implementing approved action plans, in coordination with the budget cycle.

8. Superintendent's office keeps school board, staff and community informed on progress in implementing the Strategic Plan.

9. Issue an **Annual Report on the State of TRSD Schools** to document and record over time progress, or lack of progress, in achievement of the vision, beliefs and vision statements, and strategic plan priority goals.

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Peter Scholtes, *The Team Handbook: How to Use Teams to Improve Quality* (Joiner Associates, Inc., Madison, WI., 1992).

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Virtual Learning Academy Charter School, Exeter, NH: Offers on-line courses using Internet technologies. http://www.vlac.org.

Renzulli Learning System. www.RenzulliLearning.com.

Adria Steinberg, *Real Learning, Real Work: School-To-Work as High School Reform* (NY, Routledge, 1998). Note: Six A's of Designing Projects featuring authenticity, academic rigor, applied learning, active exploration, adult connections and assessment practices. Visit Jobs for the Future website (www.jff.org), focused on dual agenda of high achievement and high student graduation rate.

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L/BPA, Existing Conditions Assessments: Timberlane High School and Middle School (L/BPA, Manchester, NH, November, 2008).

Report of the NEASC Visiting Committee for Timberlane Regional High School, pp. 48-51.

TRMS Staff and Community NEASC Self-Evaluation Study (Plaistow, NH, 2008).

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RESOURCES

Between December 2007 and December 2008, three teams, under the direction of the Strategic Planning Committee, collected a large amount of quantitative and qualitative data through surveys, archival achievement data, documents, observations, and a focus group. This information is on file in the Superintendent's Office.

Sample Goal/Strategy Implementation Worksheet

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STRATEGIC PLANNING COMMITTEE of the TIMBERLANE REGIONAL SCHOOL DISTRICT

Michelle Auger	Principal of Pollard Elementary
William Baldwin	School Board Chair, Atkinson
Charles Coker	Director of Secondary Education
Amy Dailey	Teacher at Pollard
Kristen Dalphond	Para-educator at Pollard
Kathie Dayotis	Principal of Atkinson Academy
Kate Delfino	Parent
Christine Dube	Para-educator at Danville Elementary
Angelo Fantasia	Athletic Director
Winfried Feneberg	Assistant Superintendent
Jo-Ann Georgian	Principal of Sandown North Elementary
Nancy Hart	Principal of Danville Elementary
Michael Hogan	Principal of Timberlane Regional Middle School
John Holland	Technology Director
Anne Isenberg	Parent
Krista Johnson	Teacher at Atkinson
Kelli Killen	Director of Elementary Education
Elizabeth Kosta	School Board Member, Plaistow
Richard Lalley	Consultant
Richard La Salle	Superintendent
Laura Lipfert	Parent
Doug Rolph	Principal at Sandown Central School
Nancy Stafford	Guidance Counselor at Sandown North Elementary
Jennifer Suech	Budget Committee, Atkinson
Dennis Tardif	Consultant
Donald Woodworth	Principal of Timberlane Regional High School

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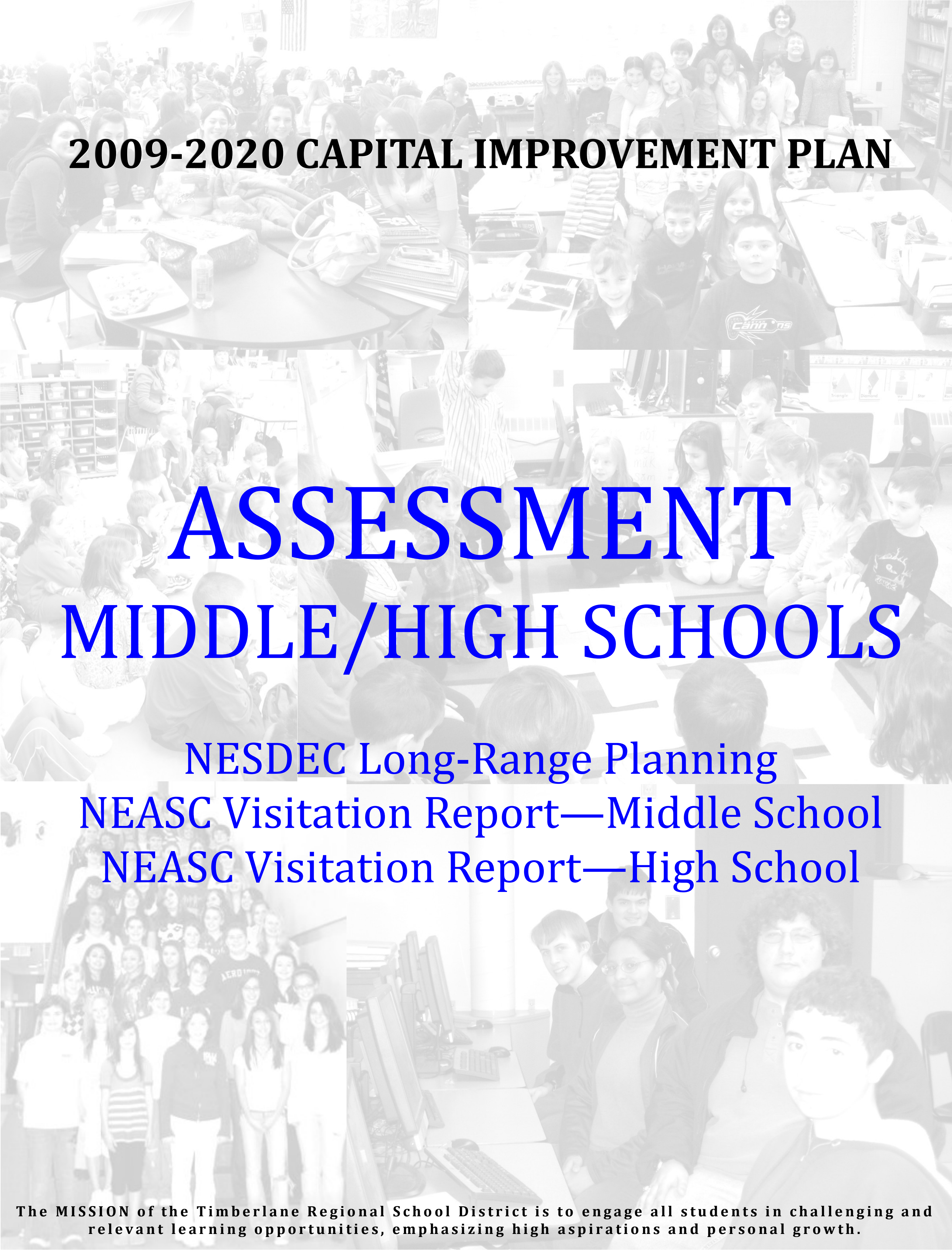

2009-2020 CAPITAL IMPROVEMENT PLAN

ASSESSMENT
MIDDLE/HIGH SCHOOLS

NESDEC Long-Range Planning
NEASC Visitation Report—Middle School
NEASC Visitation Report—High School

The MISSION of the Timberlane Regional School District is to engage all students in challenging and relevant learning opportunities, emphasizing high aspirations and personal growth.

LONG-RANGE SCHOOL FACILITIES PLANNING

TIMBERLANE REGIONAL SCHOOL DISTRICT

SAU #55, NH

(Atkinson, Danville, Plaistow and Sandown)

NOVEMBER, 2008

New England School Development Council
28 Lord Road
Marlborough, MA 01752
508-481-9444
508-481-5655 fax
www.nesdec.org
nesdec@nesdec.org

PROJECT TEAM

- Arthur L. Bettencourt, Ed.D., Assistant Executive Director
- Margery T. Clark, Ed.M., Data Collection
- Donald G. Kennedy, Ed.D., Enrollment Projections
- John H. Kennedy, M.A., Team Leader

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INTRODUCTION AND EXECUTIVE SUMMARY

NESDEC entered into an agreement with the Timberlane Regional School District to develop a Report which will serve as the basis for the adoption of a Grades 6-12 Long-Range Facilities Plan. Good long-range planning requires a specific mind-set, temporarily casting aside more immediate concerns, in order to think long-range. However, aspects of this Report can be useful in making near-term decisions in two respects: a) providing a better understanding of the long-term future of the high school and middle school buildings, thereby suggesting the assignment of grade levels to buildings in a manner that is consistent with the District's long-term plan; and b) as a guide to budget planning, so that funds can be earmarked for purposes that are consistent with intended long-range use of each facility.

The scope of the work included an analysis of PK-12 student enrollment trends, present and planned school programs, and the facilities needed to provide these programs. A member of the NESDEC Study Team visited the high school and the middle school while in session, and met with persons in the schools. We studied documents on the schools, including district goals and curriculum and program information. The NESDEC Team also conferred with a number of school and municipal officials, as well as others, resulting in the collection of school, community, and municipal data.

From 1997 to 2007, the Timberlane RSD K-12 enrollment increased by 877 pupils (from 3,717 pupils to 4,594 in 2007-2008). Assuming the current downturn in the real estate market continues for a couple of years, enrollments are forecast to decrease to 3,638 pupils by 2017-2018. Projections should be updated annually in order to identify any changes in enrollment and/or demographic patterns which might occur. Clearly, the communities that comprise the Timberlane RSD will grow in population. How many of the new families will have children of school age is a complex issue addressed in the demographic section of the Report.

After visiting the schools and consulting with school and community leaders the NESDEC Team identified the following:

STATEMENT OF THE PROBLEM

NEAR-TERM

- Need to develop a long-range plan for PK-12 facilities and educational program planning
- Need to consider purchase of additional land at the middle school/high school site to expand field space and provide for a second avenue of egress from the school campus
- Need to continue efforts to improve building security

LONG-TERM

- Need to rehabilitate/replace school spaces which do not support 21st Century educational programs
- Need to increase high school and middle school capacities and address current inadequate instructional spaces

The Timberlane Middle School and High School are generally well-maintained on a daily basis, however, they need major updates and capital improvements. Partly due to changes in educational programs that have been developed since the original design and construction of the schools, and the age of the facilities, both the middle and high school are over capacity. School programs or services have moved into regular classrooms, storage areas, alcoves and wherever else space could be carved out. The middle school and high school lack sufficient regular classroom space, most core facilities are inadequate, and the buildings are not configured or equipped to provide for 21st Century educational needs. The schools also have inadequate space for fields and parking and there are major capital improvement issues.

The NESDEC Team has developed three sets of near- and long-term options for resolving the space, upgrade, and capital improvement problems, each of which assumes some rehabilitation, construction and maintenance of school facilities. Within each option, the NESDEC Team has included a description of the option, as well as some advantages and disadvantages. All of the options are designed to serve as catalysts for further analysis and discussion. Thus, this document should be considered not as an end-product but, rather, as a beginning point for discussion, planning, and ultimate decision-making by school administrators, town officials and citizens. **In developing a Long-Range Plan, the Timberlane RSD can "mix-and-match" among the options.**

The NESDEC Team found the school staff to be cooperative and forthright in our school visits. We suggest that similar tours be organized for members of town boards (and others), so that they may observe first-hand what we have seen and have attempted to describe in this Report.

Good teaching is taking place in Timberlane RSD classrooms. Staff cheerfully "find" space for new students and programs, and enthusiastically focus on students' education. The District is engaged in thoughtful planning and prudent use of available resources. The Board of Education and Administration deserve to be commended.

I. DEMOGRAPHY AND ENROLLMENT PROJECTIONS

I. DEMOGRAPHY AND ENROLLMENT PROJECTIONS

A. TOWN-RELATED FACTORS

The preparation of enrollment forecasts is an integral part of the long-range planning process. Some of the factors to be considered in this effort pertain to the four towns of the Timberlane Regional School District specifically, the population size and age composition, growth and nature of housing units, number of births to residents, and in/out migration patterns.

Unless otherwise noted, the statistical information in Tables 1-7 is from the 2000 Federal Census, augmented and brought up-to-date by estimates. Although these data were gathered eight years ago, they offer the most complete snapshot available, and can be compared with other communities. Census data are buttressed by information gained from the Building and Planning Departments of each town, and the Timberlane Regional School Department. Municipal records from each member town and data from the New Hampshire Office of Energy and Planning were also examined. Conversations with area realtors, present and past town officials and members of the business community were also useful in preparing this Report. For case study information on student yield of multi-family properties, "Housing the Commonwealth's School-Age Children: The Implications of Multi-Family Housing Development for Municipal Expenditures," Children's Housing and Planning Association (CHAPA 2003), is furnished with this Report. Authors of the CHAPA study, Judith Barrett and Peter Sanborn, were helpful as well.

Population Size – Tables T1, T1A, T1B

The Timberlane RSD encompasses four historic communities of approximately 48.1 square miles located in Rockingham County, approximately 20 miles northeast of Nashua, 18 miles southeast of Manchester and 55 miles northwest of Boston, Massachusetts. The towns in the District are served by Routes 111, 121, 121A and 125. The District has reasonable access to Routes 101 (the Exeter Turnpike), I-93, and I-495. The towns that comprise the Timberlane RSD gained 20.9% of their population (3,993 persons) between 1990 and 2000. This was greater than the increase in Rockingham County which experienced a 12.8% increase in population during the decade of the 1990's. The State of New Hampshire experienced 11.4% growth during the same time period. The

Timberlane District's population increase of the 1990's followed a decade (1980-1990) during which the member towns' population increased 42.7%, by 5,717 persons.

TABLE T1
TOTAL POPULATION
TIMBERLANE DISTRICT

STATE OF NEW HAMPSHIRE:

		POPULATION	NO. CHANGE	% CHANGE
1980		920,610		
1990		1,109,252	188,642	20.5%
2000		1,235,786	126,534	11.4%

ROCKINGHAM COUNTY:

		POPULATION	NO. CHANGE	% CHANGE
1980		190,345		
1990		245,845	55,500	29.2%
2000		277,359	31,514	12.8%

TIMBERLANE DISTRICT:

		POPULATION	NO. CHANGE	% CHANGE
1980		13,381		
1990		19,098	5,717	42.7%
2000		23,091	3,993	20.9%

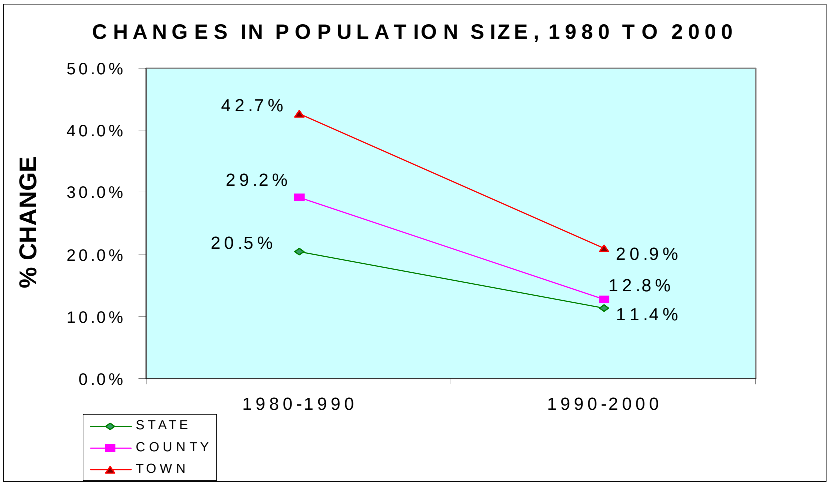


Table T1A places the towns of the Timberlane District's population in a regional context. During the 1990's, the District's population increased averaging a 2.1% annual growth rate. The 2008 Census data estimate showed that since 2000, the Timberlane RSD, as a whole, continued to experience population growth, but the average annual growth rate for the four towns slowed to 0.8% per year. This average growth rate places the Timberlane RSD at about the mid-point when it is compared to other communities in the region. Since 2000, the Census Bureau estimated that Chester experienced an annual growth rate of 3.5% while the annual growth rate in Fremont was 2.3%. During the same time period Kingston experienced 0.9% annual growth. Both Raymond and Newton had annual growth which equaled that of the Timberlane District (0.8%). Since 2000, Salem's population has grown at an annual rate of 0.7% while Derry's population has remained fairly constant. During the same time period, the Census Bureau estimated that Rockingham County's population increased at an annual rate of 1.0%. Table T1B provides historical and population projections for the Timberlane District.

TABLE T1A
REGIONAL POPULATION, 1990-2007

COMMUNITY	POPULATION 1990	POPULATION 2000	ANNUAL CHANGE 1990-2000	POPULATION 2007*	ANNUAL CHANGE 2000-2007
Atkinson	5,188	6,178	1.9%	6,572	0.1%
Danville	2,534	4,023	5.9%	4,337	1.1%
Plaistow	7,316	7,747	0.6%	7,657	-0.2%
Sandown	4,060	5,143	2.7%	5,813	1.9%
Timberlane (4)	**19,098**	**23,091**	**2.1%**	**24,379**	**0.8%**
Hampstead	6,732	8,297	2.3%	8,919	1.0%
Derry	29,603	34,021	1.4%	33,995	-
Kingston	5,591	5,862	0.5%	6,227	0.9%
Newton	3,473	4,289	2.3%	4,520	0.8%
Fremont	2,576	3,510	3.6%	4,074	2.3%
Salem	25,746	28,112	0.9%	29,498	0.7%
Chester	2,691	3,792	4.1%	4,712	3.5%
Raymond	8,713	9,674	1.1%	10,195	0.8%
Rockingham County	**245,845**	**277,359**	**1.3%**	**296,543**	**1.0%**

Source: U.S. Census Bureau ***Estimate released July 10, 2008**

TABLE T1B
TIMBERLANE RSD POPULATION, 1930-2020

	U.S. CENSUS	NH Office of Energy and Planning
1930	2,379	
1940	2,546	
1950	3,346	
1960	4,806	
1970	8,349	
1980	12,987	
1990	17,882	
2000	21,602	
2005	24,354	24,720
2007	24,379	
2010		25,640
2015		26,800
2020		27,770
2025		28,740
2030		29,650

Sources: U.S. Census (1980-2007);
NH Office of Energy & Planning (2005-2030)

Age Composition – Tables T2, A2, D2, P2, S2, 3, 4, 5

Table T2 indicates that the number and percentage of the Timberlane RSD residents under the age of 18 increased by 1,093 persons to 27.3% between 1990 and 2000. This was higher than the percentages recorded at both the county and state levels. Meanwhile, the median age in each of the towns that comprise the Timberlane RSD rose during the decade of the 1990's. According to the U.S. Census Bureau, by 2000 the median age in Atkinson was 40.9 years, while Plaistow recorded a median age of 37.4. The Census Report indicated that in 2000 the median age for Danville was 35.4, which was slightly above the 34.8 figure listed for Sandown.

TABLE T2
PERCENTAGE OF THE POPULATION UNDER THE AGE OF 18

STATE OF NEW HAMPSHIRE:

		NO. UNDER 18	% UNDER 18
1980		258,082	28.0%
1990		278,755	25.1%
2000		309,562	25.0%

ROCKINGHAM COUNTY:

		NO. UNDER 18	% UNDER 18
1980		55,977	29.4%
1990		63,971	26.0%
2000		73,329	26.4%

TIMBERLANE DISTRICT:

		NO. UNDER 18	% UNDER 18
1980		4,338	32.4%
1990		5,213	27.3%
2000		6,306	27.3%

TABLE A2
PERCENTAGE OF POPULATION UNDER THE AGE OF 18 AND MEDIAN AGE

STATE OF NEW HAMPSHIRE:

	NO. UNDER 18	% UNDER 18	MEDIAN AGE
1980	258,082	28.0%	30.1
1990	278,755	25.1%	32.8
2000	309,562	25.0%	37.1

ROCKINGHAM COUNTY:

	NO. UNDER 18	% UNDER 18	MEDIAN AGE
1980	55,977	29.4%	29.9
1990	63,971	26.0%	32.6
2000	73,329	26.4%	37.2

TOWN OF ATKINSON:

	NO. UNDER 18	% UNDER 18	MEDIAN AGE
1980	1,486	33.8%	30.5
1990	1,324	25.5%	35.9
2000	1,513	24.5%	40.9

TABLE D2
PERCENTAGE OF POPULATION UNDER THE AGE OF 18 AND MEDIAN AGE

STATE OF NEW HAMPSHIRE:

	NO. UNDER 18	% UNDER 18	MEDIAN AGE
1980	258,082	28.0%	30.1
1990	278,755	25.1%	32.8
2000	309,562	25.0%	37.1

ROCKINGHAM COUNTY:

	NO. UNDER 18	% UNDER 18	MEDIAN AGE
1980	55,977	29.4%	29.9
1990	63,971	26.0%	32.6
2000	73,329	26.4%	37.2

TOWN OF DANVILLE:

	NO. UNDER 18	% UNDER 18	MEDIAN AGE
1980	419	31.8%	29.7
1990	679	26.8%	32.9
2000	1,176	29.2%	35.4

TABLE P2
PERCENTAGE OF POPULATION UNDER THE AGE OF 18 AND MEDIAN AGE

STATE OF NEW HAMPSHIRE:

	NO. UNDER 18	% UNDER 18	MEDIAN AGE
1980	258,082	28.0%	30.1
1990	278,755	25.1%	32.8
2000	309,562	25.0%	37.1

ROCKINGHAM COUNTY:

	NO. UNDER 18	% UNDER 18	MEDIAN AGE
1980	55,977	29.4%	29.9
1990	63,971	26.0%	32.6
2000	73,329	26.4%	37.2

TOWN OF PLAISTOW:

	NO. UNDER 18	% UNDER 18	MEDIAN AGE
1980	1,797	32.0%	30
1990	1,872	25.6%	32.0
2000	2,001	25.8%	37.4

TABLE S2
PERCENTAGE OF POPULATION UNDER THE AGE OF 18 AND MEDIAN AGE

STATE OF NEW HAMPSHIRE:

	NO. UNDER 18	% UNDER 18	MEDIAN AGE
1980	258,082	28.0%	30.1
1990	278,755	25.1%	32.8
2000	309,562	25.0%	37.1

ROCKINGHAM COUNTY:

	NO. UNDER 18	% UNDER 18	MEDIAN AGE
1980	55,977	29.4%	29.9
1990	63,971	26.0%	32.6
2000	73,329	26.4%	37.2

TOWN OF SANDOWN:

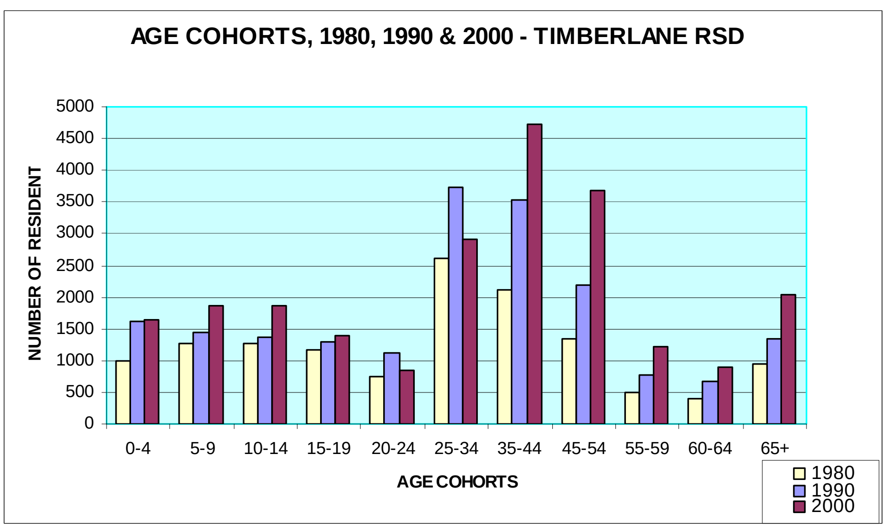
	NO. UNDER 18	% UNDER 18	MEDIAN AGE
1980	636	30.9%	29.5
1990	1,338	33.0%	30.4
2000	1,616	31.4%	34.8

Table 3 and the following graph provide valuable information for helping to project the potential for future births, as well as the potential for future turnover of housing units. **It is crucial in understanding the population dynamics in the Timberlane RSD during the decade of the 1990's to realize that the population from age 0-34 decreased by (-56) persons, whereas the age 35+ group increased by 4,049 persons.** Children in the age 0-19 cohort increased by 1,070 persons, 18.7% from the number in 1990 (5,709 children in 1990 v. 6,779 in 2000). The cohorts from ages 20-34, taken together, shrank from 4,865 persons in 1990 to 3,739 persons in 2000, a loss of -1,126 persons (-23.1%), and it is the size of this cohort that has the greatest impact on future births. The age cohort from 35-44 grew by 1,192 persons (33.6%). Although, anecdotally, we know of women in this latter age range now giving birth, the number of births to this age group remains considerably smaller than the number of births to younger women (88% of births to the younger group v. 12% of births to the older group). See "Age-Specific Fertility Rates" graph. It is unlikely that the Timberlane RSD would experience any substantial increase in the number of births in the near future. Births are discussed further in Table 8.

The "gen x'ers" and "baby boomers" from age 35-59, however, grew by 3,127 persons. In the 1990's, the number of residents age 65 and above increased by 710 to 2,044. This increase of residents in the age 65 and above cohort can be an important factor in projecting the potential for property turnover (see the discussion of Table 7 in this regard). The 212 person (31.1%) increase in the ages 60-64 cohort coupled with the 53.2% increase in the number of residents over 65 indicates the Timberlane RSD may continue to experience a turnover of the "over 60" population in the short-term future. A more significant turnover may be expected as the current housing downturn comes to an end and more of the "baby boomers" begin to retire as we near the end of the decade. A community can grow in its school population through the turnover of existing housing stock from families with no young children (the "empty nesters") to families with young children.

TABLE 3
AGE COHORT DATA – TIMBERLANE RSD

	SIZE OF COHORT			
AGE	1980	1990	2000	% CHANGE, 1990 TO 2000
0-4	997	1612	1647	2.10%
5-9	1263	1432	1860	29.8%
10-14	1268	1374	1871	36.1%
15-19	1161	1291	1401	8.5%
20-24	752	1128	839	-25.6%
25-34	2619	3737	2900	-22.3%
35-44	2126	3542	4734	33.6%
45-54	1333	2199	3677	67.2%
55-59	508	769	1226	59.4%
60-64	406	680	892	31.1%
65+	948	1334	2044	53.2%
TOTAL:	13,381	19,098	23,091	20.9%



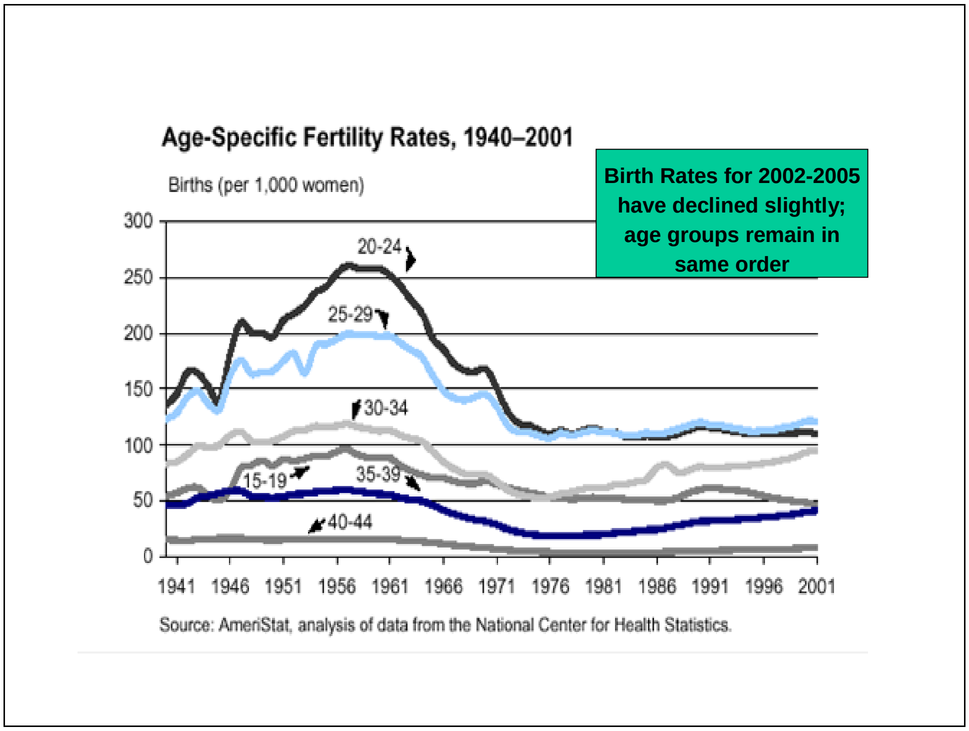


Table 4 indicates a (R) K-12 public school population that increased in the 1980's at a slightly higher rate than the state with regard to the percentage of the total population in the (R) K-12 enrollment. During the 1990's, the percentage of the Timberlane RSD total population that was enrolled in Grades (R) K-12 increased slightly from 16.0% in 1990 to 18.0% in 2000. During the same time period, the percent of the state population that was enrolled in Grades (R) K-12 increased by 1.3% (see the Historical Enrollments that follow in Tables 9 and 10).

Table 5 and the related graph display the Population by Race and Hispanic Origin. Growth through the 1990's in the non-white population is greater in the state as a whole than in the Timberlane RSD. The Timberlane RSD's absolute numbers and percentages remain substantially smaller than both county and state percentages. The apparent growth in the "Other" category is, in part, due to a redefinition by the Bureau of the Census. "Other" now includes persons of more than one race who heretofore had to be identified as one race or another.

TABLE 4
PERCENTAGE OF (R) K-12 ENROLLMENT IN POPULATION

STATE OF NEW HAMPSHIRE:

	POPULATION	PUBLIC (R)K-12 ENROLLMENT	% (R)K-12 ENR. IN POPULATION
1980	920,610	167,232	18.2%
1990	1,109,252	172,785	15.6%
2000	1,235,786	208,461	16.9%

TIMBERLANE DISTRICT:

	POPULATION	PUBLIC (R)K-12 ENROLLMENT	% (R)K-12 ENR. IN POPULATION
1980	13,381	2,905	21.7%
1990	19,098	3,059	16.0%
2000	23,091	4,156	18.0%

TABLE 5
PERCENTAGE BY RACE AND HISPANIC ORIGIN

STATE OF NEW HAMPSHIRE:

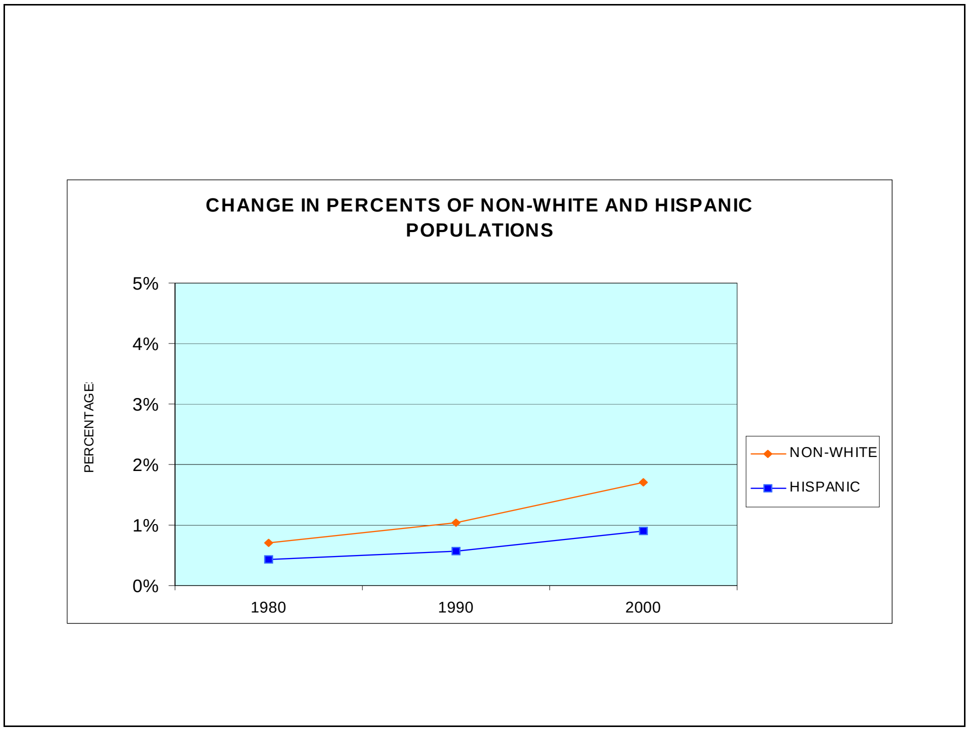
	WHITE	BLACK	ASIAN	OTHER	% NON-WHITE	HISPANIC ORIGIN (of any race)	% HISPANIC
1980	910,099	3,990	2,929	3,592	1.1%	5,587	0.6%
1990	1,087,433	7,198	9,343	5,278	2.0%	11,333	1.0%
2000	1,186,851	9,035	15,931	23,969	4.0%	20,489	1.7%

ROCKINGHAM COUNTY:

	WHITE	BLACK	ASIAN	OTHER	% NON-WHITE	HISPANIC ORIGIN (of any race)	% HISPANIC
1980	187,320	1,469	772	784	1.6%	1,226	0.6%
1990	240,203	2,326	2,266	1,050	2.3%	2,395	1.0%
2000	268,486	1,619	3,084	4,170	3.2%	12,166	4.4%

TIMBERLANE DISTRICT:

	WHITE	BLACK	ASIAN	OTHER	% NON-WHITE	HISPANIC ORIGIN (of any race)	% HISPANIC
1980	7,611	37	26	32	0.7%	59	0.4%
1990	18,896	54	97	49	1.0%	108	0.6%
2000	22,722	81	144	167	1.7%	209	0.9%



The 2000 Census reported 740 foreign-born residents. Of the 285 persons reporting that they speak English less than "very well," 224 speak other European languages, 29 speak Spanish and 32 speak Asian languages. When persons were asked to identify their ancestry, 6,170 reported Irish; 5,728 English, Scottish, or Welsh; 5,283 reported French or French Canadian; 3,448 reported Italian; and 1,667 German, to note the largest identified groups.

Housing Growth – Tables 6, 6A, 6B, 6C, 7

During the 1990's in the Timberlane RSD, the number of dwelling units increased by 1,590 as compared to a 2,325 dwelling unit increase experienced by the district in the 1980's. The 1990 Census had listed 7,024 dwelling units. At the time of the 2000 Census, 8,614 dwelling units were listed. Of these, 96.4% were occupied and 3.6% were vacant. Of the 304 vacant dwellings, 171 were for "seasonal, recreational, or occasional use" (Table 6B). Since 2000, several factors have come into play that have contributed to a decline in the Timberlane RSD's residential growth rate. These include the following:

- A decline in the average number of residential permits issued district-wide from 215 in 1997 to 52 permits issued in 2007. In the first half of 2008, only eight residential permits were issued within the District (see Table 6A).

- According to the Planning and Building Departments in the District's member communities, a significant decline has occurred during the past three years in the number of proposals for sub-division approvals within the District (this is true in each of the four communities).
- Realtors report that the sale of existing homes within the District declined by between 10-20% from 2007-2008. Existing home sales are down by a somewhat larger percentage when compared to the peak years of 2003-2005.
- Realtors also indicate that, although the over 55 age cohort continues to increase in size, because of the decline in housing market, many "empty nesters" are postponing downsizing to smaller homes until the real estate market rebounds.

Several regional factors currently are at play that may influence the Timberlane RSD real estate market, with potential to cause a continued slow down in housing growth:

- Residential investment now accounts for 6% of the Gross Domestic Product (GDP), the highest since 1955.
- The ratio of median mortgage payments to median income (a gauge of affordability) is at its highest level since 1989, when residential prices last peaked.
- The increasing number of foreclosures on "sub-prime" mortgages has resulted in a tightening of eligibility for mortgage loans, causing the real estate slowdown to linger. Because other areas of the economy are affected by the real estate market (and by overall tightening of credit), the regional and national slowdowns may affect the Timberlane RSD for some time to come.

The 2000 Census documented (Table 6C) that 3,581 Timberlane RSD households (43%) had moved into their dwelling during the five-year period between 1995-2000; 1,498 households (18%) moved in from 1990 to 1994. Thus, in 2000, 61% of the Timberlane RSD's residents had moved into their dwelling within the most recent decade, indicating significant mobility. The Census Bureau found that 1,724 households had moved into their units between 1980 and 1989 (21%); 991 between 1970 and 1979 (12%); and 516 moved in prior to 1970 (6%). The latter two percentages, when combined with the number of residents who are currently over or approaching 55, suggest a significant potential for homes to come on the market during the early part of the 2010-2020 decade.

In addition to new construction, property turnover can increase school enrollments. During the next decade, the Timberlane RSD is likely to experience increased demand for age-restricted housing. The impact of this type of housing development upon the school system is referred to as having an “echo effect.” As seniors seek to downsize, their properties come on the market for potential purchase by young families, thus increasing the school population.

The lag from permitting to occupancy to full impact upon school enrollment is described later in the Report. In addition to new dwellings, there are a number of additions or remodelings each year. The number of persons per household is currently 2.7 persons (Table 6). The Timberlane District’s numbers per household unit have been higher than the state average and equal the 2.7 persons per Timberlane RSD unit reported in the 1990 Census.

TABLE 6
NUMBER OF DWELLING UNITS AND PERSONS PER UNIT

STATE OF NEW HAMPSHIRE:

	NO. OF DWELLING UNITS	% CHANGE	PERSONS PER UNIT
1980	386,381		2.4
1990	503,904	30.4%	2.2
2000	547,024	8.6%	2.3

ROCKINGHAM COUNTY:

	NO. OF DWELLING UNITS	% CHANGE	PERSONS PER UNIT
1980	76,115		2.5
1990	101,773	33.7%	2.4
2000	104,529	2.7%	2.7

TIMBERLANE DISTRICT:

	NO. OF DWELLING UNITS	% CHANGE	PERSONS PER UNIT
1980	4,699		2.8
1990	7,024	49.5%	2.7
2000	8,614	22.6%	2.7

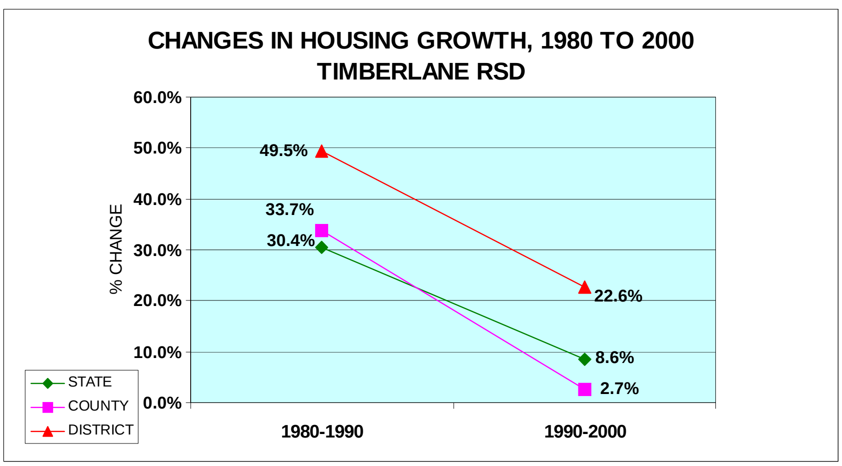


TABLE 6A
TIMBERLANE DISTRICT (4 TOWNS) BUILDING PERMITS

Year	Single-Family	Two-Family	Multi-Family Units	TOTAL
1997	203		12	215
1998	146	6	19	171
1999	135	22	58	215
2000	132			132
2001	172			172
2002	160			160
2003	98			98
2004	72	4	19	95
2005	136		4	140
2006	34			34
2007	52			52
2008 to 7/1	8			8

Sources: Planning Department and Building Inspector as reported to HUD

TABLE 6B
TIMBERLANE RSD
HOUSING DETAIL 1990 v. 2000

1990 Dwellings	Occupied	Vacant	2000 Dwellings	Occupied	Vacant
7,024	6,574	450	8,614	8,310	304
476 mobile homes		191 for seasonal use	428 mobile homes		171 for seasonal use

Source: U.S. Census, Tables DP-1, 4

TABLE 6C
YEAR HOUSEHOLDER MOVED INTO UNIT

	Number	Percent
1995 to March 2000	3581	43%
1990 to 1994	1498	18%
1980 to 1989	1724	21%
1970 to 1979	991	12%
1969 or earlier	516	6%

As reported in the 2000 Census, the median household incomes within the Timberlane RSD were $69,729 in Atkinson, $57,287 in Danville, $61,707 in Plaistow, and $67,581 in Sandown. "Management/Professional" (38.2%); "Service Occupations" (9.7%); "Sales and Office Occupations" (28.8%); and "Production, Transportation, and Material Moving" (13.7%) were the largest occupations. "Manufacturing" (21.1%); "Education/Health" (17.9%); "Retail Trade" (15.4%); "Construction" (7.0%); "Finance, Insurance and Real Estate" (6.0%) and "Entertainment, and Recreation" (4.0%) provided the largest number of jobs. There were 151 families with incomes below the poverty level; of these, 104 families had children under the age of 18, and 24 of those families had children under age five. In 86 instances, grandparents were the primary caregivers for children under the age of 18.

Table 7 and graph display the number of (R) K-12 Timberlane RSD public school students per dwelling unit. This statistic decreased from .62 in 1980 to .44 in 1990 and then increased slightly to .48 in 2000. Roughly speaking, every ten households will yield five public school students, a statistic higher than the state as a whole (.38 public school students per dwelling unit). In the 2000 census, 6,306 (see Table T2) Timberlane RSD residents were under 18 years of age. This number (27.3%) includes students in public, private, parochial, and vocational school, school dropouts, and those too young for school.

TABLE 7
NUMBER OF (R) K-12 STUDENTS PER DWELLING UNIT

STATE OF NEW HAMPSHIRE:

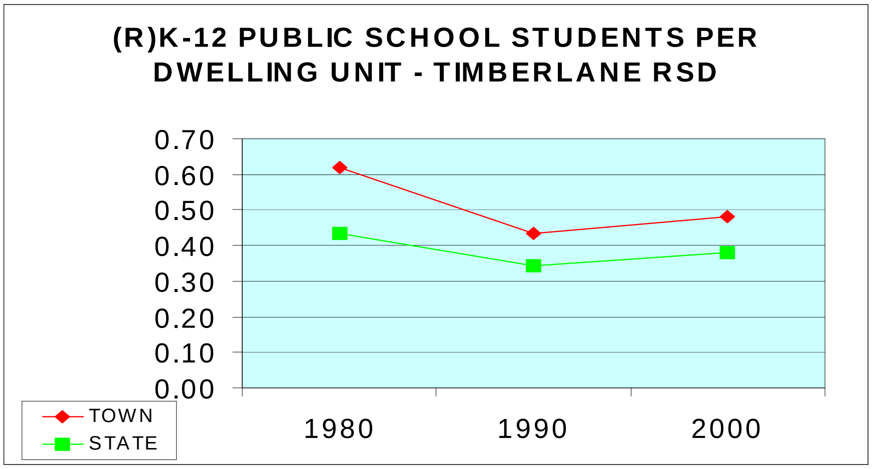
	# OF HOUSING UNITS	PUBLIC (R)K-12 ENROLLMENT	(R)K-12 STUDENTS PER UNIT
1980	386,381	167,232	0.43
1990	503,904	172,785	0.34
2000	547,024	208,461	0.38

2000 Number of Households with individuals under 18: 168,371
2000 Percentage of Households with individuals under 18: 35.5%

TIMBERLANE DISTRICT:

	# OF HOUSING UNITS	PUBLIC (R)K-12 ENROLLMENT	(R)K-12 STUDENTS PER UNIT
1980	4,699	2,905	0.62
1990	7,024	3,059	0.44
2000	8,614	4,156	0.48

2000 Number of Households with individuals under 18: 3,352
2000 Percentage of Households with individuals under 18: 38.9%



Births – Table 8

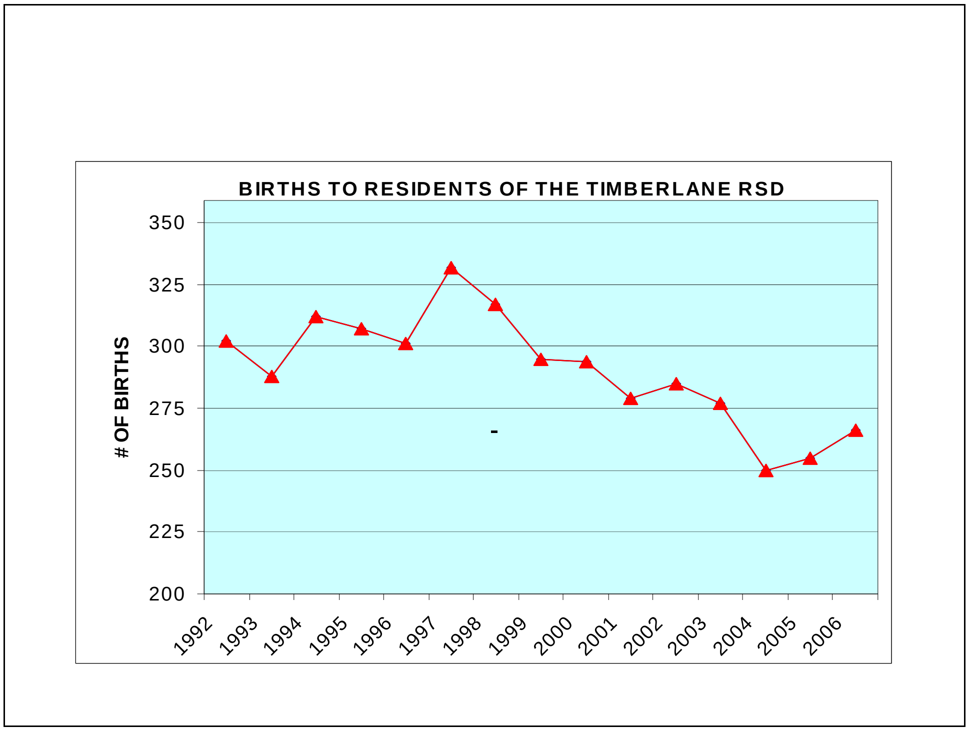
Table 8 and the accompanying graph display the number of births within the Timberlane RSD from 1992 to 2006. Over the past 15 years, the number of births has fluctuated ranging from a high of 332 in 1997 to a low of 250 in 2004. The five year average for the period from 2002-2006 was 267 births per year as compared to an annual average of 303 births between 1997 and 2001. It should be noted that town clerks do not receive notification of all births to residents of the Timberlane RSD, as some births take place out of the District or area. Therefore, figures from the New Hampshire Department of Public Health are used in projection calculations.

Given the shrinking number of persons in the 20-34 age cohort described in Table 3, there appears to be little potential for the annual number of births to current residents to rise significantly in the near-term. It is expected that the annual number of births to Timberlane RSD residents will remain in the 265-270 range.

TABLE 8
LIVE BIRTHS TO RESIDENTS OF THE TIMBERLANE DISTRICT

YEAR	# OF BIRTHS	AVERAGE	% CHANGE
1992	302		
1993	288		
1994	312	302	
1995	307		
1996	301		0.5%
1997	332		
1998	317		
1999	295	303	
2000	294		
2001	279		-12.1%
2002	285		
2003	277		
2004	250	267	
2005	255		
2006	266		

Source: NH Department of Public Health



B. HISTORICAL ENROLLMENT

Historical Enrollment – Public Schools – Tables 9, 10

The K-12 historical enrollment for Timberlane RSD students over the past 11 years is shown in Table 9 and the following graph. During the period from 1997 to 2004, the enrollment increased from 3,717 to 4,522 students. The 2007 enrollment of 4,594 is 877 students higher than the 3,717 student population that was enrolled in 1997. (The 2007 enrollment figure includes the 228 students enrolled in the Kindergarten program which was instituted in 2007.) Table 10 displays the enrollment in grade combinations. In 2007, students registered in public Kindergarten, represented about 80% of the Timberlane RSD births five years previously.

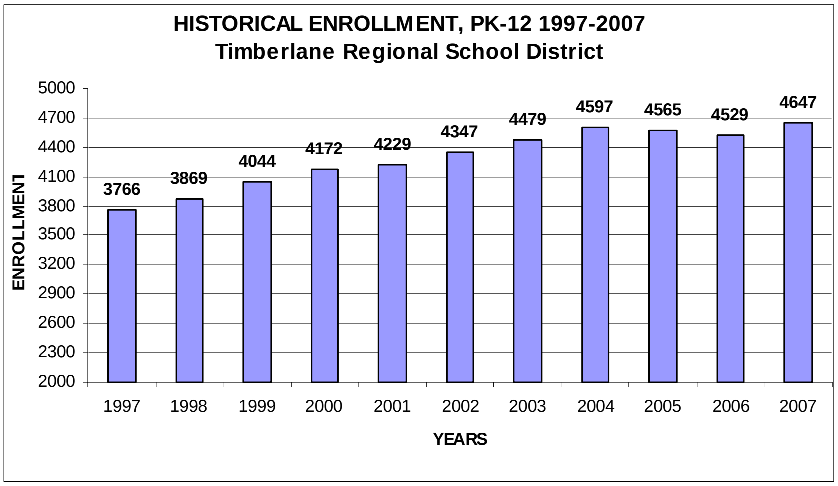
The progress of a class from Grade 1 through the grades can be traced by drawing a diagonal line from Grade 1, dropping in the following year to Grade 2 then to Grade 3, etc. Between Grades 1 and 5, enrollments have remained fairly constant. Grades 6 and 7 have each experienced approximately 1-2% increases, while in Grades 8-11, enrollments have declined by an average of 1% per year over the past five years. At Grade 12, enrollments have averaged a 1% increase per year.

TABLE 9
TIMBERLANE RSD HISTORICAL ENROLLMENT, 1997-2007

SCHOOL YEAR	K	1	2	3	4	5	6	7	8	9	10	11	12	K-12 TOTAL
1997-98		358	395	350	337	356	334	284	295	286	281	249	192	3717
1998-99		344	363	375	377	334	364	315	294	324	272	242	204	3808
1999-00		347	367	362	404	371	343	365	335	291	309	251	215	3960
2000-01		350	357	369	370	412	371	344	372	336	289	283	233	4086
2001-02		349	354	349	368	373	400	369	348	369	333	276	259	4147
2002-03		342	354	353	358	373	382	414	372	339	369	323	268	4247
2003-04		375	345	362	357	357	383	395	436	365	338	367	315	4395
2004-05		365	382	364	373	367	367	396	393	439	365	342	369	4522
2005-06		340	365	370	360	376	368	377	396	397	427	356	347	4479
2006-07		321	332	361	369	356	373	369	378	377	400	430	388	4454
2007-08	228	291	334	334	354	375	357	373	381	379	372	386	430	4594

TABLE 10
TIMBERLANE RSD HISTORICAL GRADE COMBINATIONS

SCHOOL YEAR	K-2	K-5	K-6	K-8	5-8	6-8	7-8	7-12	9-12
1997-98	753	1796	2130	2709	1269	913	579	1587	1008
1998-99	707	1793	2157	2766	1307	973	609	1651	1042
1999-00	714	1851	2194	2894	1414	1043	700	1766	1066
2000-01	707	1858	2229	2945	1499	1087	716	1857	1141
2001-02	703	1793	2193	2910	1490	1117	717	1954	1237
2002-03	696	1780	2162	2948	1541	1168	786	2085	1299
2003-04	720	1796	2179	3010	1571	1214	831	2216	1385
2004-05	747	1851	2218	3007	1523	1156	789	2304	1515
2005-06	705	1811	2179	2952	1517	1141	773	2300	1527
2006-07	653	1739	2112	2859	1476	1120	747	2342	1595
2007-08	853	1916	2273	3027	1486	1111	754	2321	1567


HISTORICAL ENROLLMENT, PK-12 1997-2007
Timberlane Regional School District
ENROLLMENT
5000
4700
4400
4100
3800
3500
3200
2900
2600
2300
2000
3766
3869
4044
4172
4229
4347
4479
4597
4565
4529
4647
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
YEARS

C. PROJECTED ENROLLMENT – Methodology

The data reported below are "status quo," that is, without the impact of an increased rate of development of residential housing. The cohort survival technique is the most frequently used method of preparing school enrollment forecasts. NESDEC uses this technique, but modifies it in order to move away from forecasts that are wholly computer or formula driven. Such modification permits the incorporation of important and current town-specific information into the generation of the enrollment forecasts. Basically, percentages are calculated from the historical enrollment data to determine a reliable percentage of increase or decrease in enrollment between any two grades. For example, if 200 students were enrolled in Grade 1 in 2006-2007 and the class increased to 220 students in Grade 2 in 2007-2008, the percentage of survival would have been 110%, or a ratio of 1.10. Such ratios are calculated between each pair of grades or years in school over several recent years.

The ratios used are the key factors in the reliability of the projections, given the validity of the data at the starting point. The strength of the ratios lies in the fact that each ratio encompasses **collectively** the variables that could possibly account for an increase or decrease in the size of a grade enrollment as it moves on to the next grade. Each ratio, then, represents the cumulative effect of the following factors:

1. Migration, in or out, of the schools
2. Changes in school program
3. Dropouts, transfers, etc.
4. Births and deaths
5. Housing growth and housing turnover

Based upon a reasonable set of assumptions in regard to each of these factors, ratios most indicative of present/future trends are determined for each pair of grades or years. To project for the future, the ratios thus selected are applied to the present enrollment statistics for a predetermined number of years. In the case of the Timberlane RSD, the assumptions based upon earlier historical patterns of the past five-ten years would be these:

1. The annual number of births to Timberlane RSD residents through 2017 will remain in the range of 265-270 per year.

2. Single-family housing growth over the next ten years will continue to be at approximately 40-50 units per year.
3. The pattern and numbers involved in the turnover of existing single-family housing stock will not change appreciably from the recent past.
4. Kindergarten will continue at 80% of births five years previously. Little change will occur in the existing enrollment patterns between Grades 1 and 8.
5. The high school level out migration rate will remain at approximately 1% per grade per year.
6. The percentage of Timberlane RSD students in non-public schools and in home-schooling will continue at present levels.

If any of these assumptions needs to be altered in the future, so, too, will the projections. It is important to note that NESDEC annually updates projections for affiliated school districts at no cost. This provides an opportunity for the District to plan adequately for any changes that might occur.

Reliability of Projections

While the reliability of projections, in general, rests upon the soundness of the assumptions upon which they are based, there are degrees of reliability over the grades and the ten-year period shown. **The enrollment projection in Table 11 can be divided into three sections. The top and largest section represents the projections based on students who are already enrolled in the Timberlane RSD. This projection has the highest reliability. The projections based on children who have been born, but are not yet in school are somewhat less reliable. The projections for students who are not yet born are the least reliable projections.** Close liaison with the private Preschools will help to establish contact with those who later may be attending the Timberlane RSD. Keeping track of this number will give the district a rough estimate of the potential increase in Kindergarten registrations. A ten-year projection (which drops in reliability after the fifth year) is a very small window into the future. The "leveling" of the elementary enrollment, which occurs in years six-ten of the projections, is caused by holding the births stable during that period. If the births should increase during that period (reversing the trend of the last several years) the Kindergarten class will increase, an increase that would ultimately spread to all the elementary grades.

If the rate of housing growth were to increase dramatically from past levels (or if property turnover increased markedly), the projections would rise. At all grade levels, improved programs/facilities could lead to additional Timberlane RSD residents attending (or remaining in) the public schools. Ten-year enrollment projections are just that, projections, they are not guarantees. Whatever the School Board chooses to do in making plans, it should take into account the possibility of a 10% swing either way in terms of enrollment at all grade levels. In other words, the School Board should be prepared to respond to the questions: “How will the space be used if 10% **fewer** students materialize?” and “How will the space be provided if 10% **more** students materialize?”

Projected Enrollment, 2007-2008 to 2017-2018 – Tables 11, 12

Based upon these earlier historical patterns, the total public school enrollment PK-12 (as displayed in Table 11 by grade level, and in Table 12 in grade combinations), would be projected to decline over the next ten years. The October 1, 2007 enrollment was 4,594. In 2011, enrollment is projected to decrease to 4,156 and then to further decrease to 3,648 in 2017. ***Accelerated development and/or rapid property turnover, however, could add enrollments above the numbers projected in Tables 11 and 12 and the graphs (see discussion on page 28).***

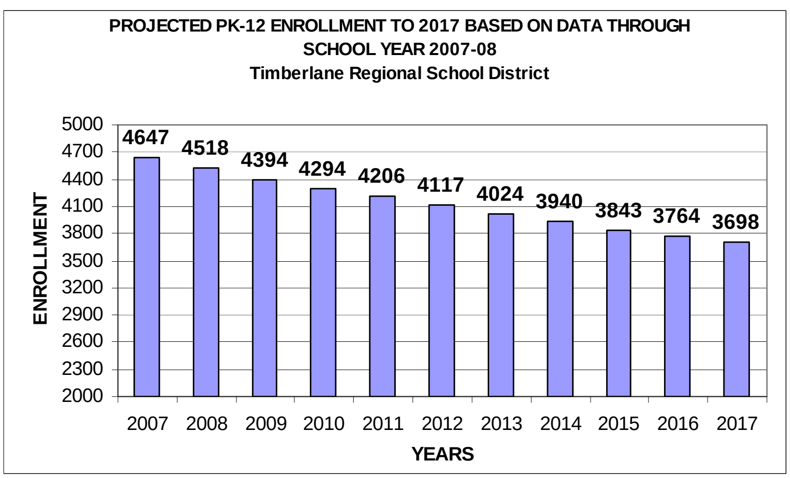
All of these factors bear careful watching. As new information is obtained, it can be used to further illuminate and/or modify the enrollment projections for the Timberlane RSD. For example, by tracking building permits and property sales, future enrollments can be forecast which will update or modify these projections.

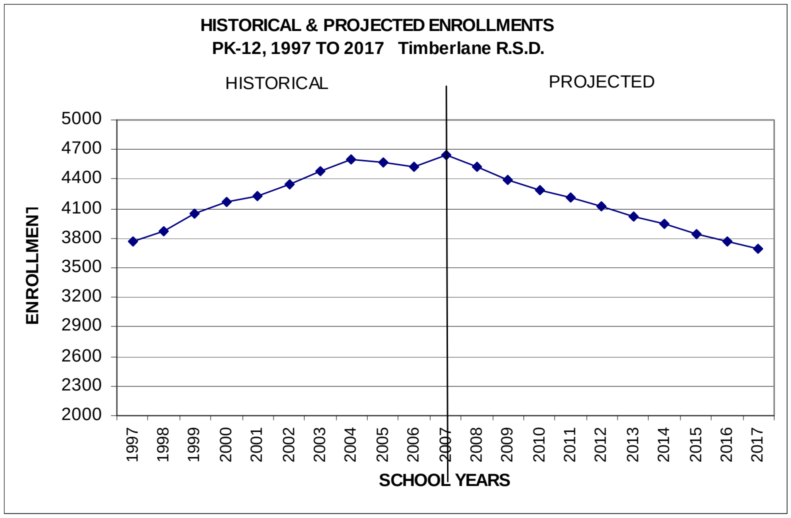
TABLE 11
TIMBERLANE RSD PROJECTED ENROLLMENT, 2008-2017

SCHOOL YEAR	K	1	2	3	4	5	6	7	8	9	10	11	12	K-12 TOTAL
2007-08	228	291	334	334	354	375	357	373	381	379	372	386	430	4594
2008-09	248	264	295	337	335	357	378	359	377	382	375	370	391	4468
2009-10	218	283	268	297	337	338	361	380	363	378	375	372	374	4344
2010-11	222	253	287	269	298	340	343	363	383	364	373	373	376	4244
2011-12	233	259	257	288	270	301	345	345	366	383	360	371	378	4156
2012-13	235	268	263	258	289	273	307	349	349	366	376	358	376	4067
2013-14	230	272	272	265	259	292	276	309	352	350	361	374	362	3974
2014-15	227	265	276	273	266	262	295	278	312	353	346	359	378	3890
2015-16	230	263	269	277	274	269	264	297	281	314	348	344	363	3793
2016-17	231	266	267	270	278	277	273	266	300	282	311	345	348	3714
2017-18	231	266	270	268	271	281	280	274	269	301	279	309	349	3648

TABLE 12
TIMBERLANE PROJECTED GRADE COMBINATIONS

SCHOOL YEAR	K-2	K-5	K-6	K-8	5-8	6-8	7-8	7-12	9-12
2007-08	853	1916	2273	3027	1486	1111	754	2321	1567
2008-09	807	1836	2214	2950	1471	1114	736	2254	1518
2009-10	769	1741	2102	2845	1442	1104	743	2242	1499
2010-11	762	1669	2012	2758	1429	1089	746	2232	1486
2011-12	749	1608	1953	2664	1357	1056	711	2203	1492
2012-13	766	1586	1893	2591	1278	1005	698	2174	1476
2013-14	774	1590	1866	2527	1229	937	661	2108	1447
2014-15	768	1569	1864	2454	1147	885	590	2026	1436
2015-16	762	1582	1846	2424	1111	842	578	1947	1369
2016-17	764	1589	1862	2428	1116	839	566	1852	1286
2017-18	767	1587	1867	2410	1104	823	543	1781	1238





Accelerated Residential Growth: Potential Impact on Enrollments

Although the sales of new and existing housing have slowed during the past several years, there are several factors which indicate that the District has room for considerable residential growth, once the housing downturn comes to an end. These factors include the following:

- Planning Department members and realtors agree that there are still large parcels of buildable land available in each of the Timberlane District's four member communities.
- During the next decade, there will be significant demand within the District for over 55 age-restricted housing (see reference above to the unusually large number of persons in this age group). Several proposals, including a large development at the Atkinson Country Club, have been referenced by Planning Department members and realtors. However, at this time, due to market conditions, progress in this direction is slow. Once the housing downturn is ended and more age-restricted housing is constructed, it is likely that some residents of the District

communities will opt to sell their three- and four-bedroom homes, making properties available for purchase by families with school-aged children.

- Some builders in the area have indicated that in the near future they will be constructing smaller homes that are in the more affordable price range. Such a move would be likely to draw younger families with school-aged children into the District.

Because of the present uncharted economic times, it is impossible to predict when these growth factors will begin to affect Timberlane District enrollments. However, it is likely that during the next decade the District will experience significant residential expansion resulting in accelerated population growth. This growth, when coupled with contemplated improvements in District buildings and educational programs, has the potential to increase Timberlane RSD K-12 enrollments by 300-500 students above the estimates that are included in the status quo projections listed in Tables 11 and 12.

Although single-family residences make up almost all of the present housing stock, certain built up neighborhoods are likely to experience additional condominium and other multi-family construction. The Planners do foresee that more multi-family units will be built in the near future, thus we have included information about such housing from a study which we find helpful in describing the potential for school enrollments.

Housing, Families and School-Age Children (excerpts from "Housing the Commonwealth's School-Age Children," CHAPA 2003)

- Compared to single-family homes, new multi-family developments almost always house fewer school-age children per dwelling unit. (There is a myth that the number would be greater...NESDEC.)
- The probability that multi-family developments will generate school children is influenced by several factors, including:
  - <u>The number and percentage of dwelling units sized for family households</u>. In virtually all cases, developments that offer three- or four-bedroom units generate more school children per unit than developments limited to one- and two-bedroom units.
  - <u>The reputation of a community's public schools</u>. In most cases, multi-family developments in suburbs with prestigious school systems house more school-

age children than communities with average or less competitive schools. The same usually holds true for single-family homes.

  - Scale, density and location. Large, high-density multi-family developments appear to be less attractive to families with children than low-rise, moderately dense developments with fewer units per building. Developments that offer yards, walkways and common open space typically house more children. In addition, developments located near schools, playgrounds, or established residential areas – developments that connect logically to adjoining neighborhoods and the larger community – usually have more children than developments that are isolated, by location or design, or occupy sites near offensive land uses.
  - Composition, age and character of existing housing stock. In communities with relatively high percentages of two-, three- or four-unit homes in traditional neighborhoods, new multi-family developments seem to attract fewer families with school-age children.
  - Units for low- and moderate-income households. Multi-family housing developed exclusively or primarily as affordable to low- and moderate-income families generates more children than a development with 25% low- and moderate-income units, i.e., the minimum required for comprehensive permit development. (The multiplier for low- and moderate-income is generally in the range of 130-140% for 2 BR [and 160% for 3 BR], although a myth exists that the number would be far greater…NESDEC.)

- In high-growth communities, large multi-family developments that include three- or four-bedroom units accelerate the need for new or expanded community facilities, notably schools.

New multi-family developments often attract occupants who already live in the community. (In the case of the Timberlane RSD, these may be seniors…NESDEC.) The scale, character and location of a new development, coupled with the cost to live there, will influence the extent to which it generates children from in-town moves.

II. SCHOOL CAPACITIES

As part of the Long-Range School Facility Master Plan, the Current Operating Capacity (COC) and the Planned Operating Capacity (POC) were determined for each school. The COC is based on **current usage** of the building, including classrooms, core, and specialized areas. This figure may differ from the architects for it includes all spaces used for instructional purposes, some of which may be inappropriate, or temporary portable classrooms. The POC is based on **planned usage** of the building, recommended class size policy, **elimination of space needs or deficiencies**, and the inclusion of appropriate classroom, laboratory, core (auditorium, Library, gym, etc.) and special use areas (Special Education, Art, Music, instructional specialists, etc.). Temporary, portable classrooms are **not** included in the POC. Analyzing each space in the schools, observing the schools while in session, reviewing the program of studies, and interviews with staff are all included in the process of determining school capacities. The POC connects the demands/requirements of the educational program to the facilities needs of that program.

Counting the number of rooms in a school is relatively straightforward. However, counting "classrooms" for the purpose of establishing student capacity (i.e., "homerooms") is more complex…especially in an open space school with few walls or temporary moveable walls. What does NESDEC count as a "classroom?" Although New Hampshire has square footage guidelines for elementary/middle/high school general purpose classrooms, in older schools a classroom may be somewhat smaller. NESDEC does not automatically exclude a room of 600-700 square feet from its count. NESDEC looks at square footage, program uses, and code issues. The Life Safety Code of the National Fire Protection Association (NFPA) requires two means of egress from a classroom. Thus, NESDEC would not count a room with a single exit as a classroom although the room might be satisfactory for other uses. Finally, a room with adequate square footage and adequate egress could be devoted to a use other than housing a "homeroom" (e.g., might be the Art or Music room, or the only Teacher Workroom-Lunchroom) in which case, NESDEC would not count it as a classroom. For each school, the detailed room count is indicated as a "full-sized room" or "conference-sized room" and its use is noted. The FACILITY PROFILE pages describe the unique program uses of the rooms in each school. Factors unique to middle/high schools are described.

The reader will note that NESDEC's method of calculating school capacity is directly related to the ever-changing educational program. For the purposes of a quick snapshot, architects often will divide the gross square footage of an existing school by a square-foot-per-pupil ratio in order to make a quick estimate of the school's capacity. Sometimes the architect may multiply the result by a factor of 90% for elementary schools and 70-85% for middle and high schools in order to acknowledge that no school can schedule 100% of its space all of the time. Although commonly applied and somewhat useful, the resulting estimated "capacity" ignores the actual configuration of space in the school. In NESDEC's experience, there are many older schools in which a disproportionately large amount of the square footage is found in large hallways, foyers or locker rooms; or extra shop, gym or auditorium space…while the school has too few academic classrooms, an overcrowded cafeteria, etc., or other problems of configuration which act to lower the effective student capacity of the facility for offering a high quality 21st Century educational program.

A. HIGH SCHOOL CAPACITY

The process for determining the capacity for a high school is similar to that used for the elementary/middle schools only in that support areas, such as cafeteria, auditorium, offices, and those areas for special needs instruction, departmental resource rooms, internal suspension room, and prep-storage rooms, are not counted in the capacity.

At the high school level, in addition to the general classrooms, the special area rooms such as Art rooms, laboratories and shops **are** included in the determination of capacity. Each general classroom has been assigned a capacity depending upon size and use. The capacity assigned to each special area room is usually contingent upon the number of workstations existing in the space. Once the capacity of each instructional space is determined, a total capacity can be computed based on the sum of the individual capacities.

No high school (or middle school) building can operate effectively at 100% capacity. First, students cannot be scheduled into neat groups of 25, 22 or 20. Second, the elective system provides opportunities for students to choose from a variety of course offerings. Third, schools which choose to provide ability-level grouping, enrichment classes and programs for the academically advanced, accept increased problems in achieving evenly-balanced classes. A comprehensive educational program requires, therefore, a greater number of teaching stations than would be the case in a school without an elective program. If secondary schools were to operate at total capacity, comprehensiveness and course electives would have to be severely curtailed. For this reason, the operating capacity of a high school reflects not only spaces available, but also the program design of the school and is calculated in the Timberlane RSD High School at 85% of the maximum capacity of the building. General classrooms were assigned 25 pupils as described in the capacity charts which follow. See, also, the reference above to undersized classrooms. An alternative method for calculating the capacity of middle schools uses a 70% or 75% multiplier for schools following a complete “middle school model” v. the 85% multiplier used for high schools and “junior high schools.” Middle schools typically are less space-efficient than high schools due to their pattern of scheduling.

B. MIDDLE SCHOOL CAPACITY

To determine the capacity of a middle school, an inventory is made of spaces available for instructional use. Each instructional space is assigned a capacity based upon its use and school practice relative to class size and grouping of students. Consideration is also given to the way in which middle schools are organized and operated.

Middle schools recognize the special developmental differences – physical, intellectual, social, and emotional – of pre- or early-adolescents. Recent research suggests that a curriculum and instructional program which takes into account the differences in these students “in transition” positively affects student achievement, personal development, learning climate, faculty morale, staff development, and parental and community involvement. The POC incorporates facility space to address these needs and differences.

Because students are moving along a developmental continuum, a middle school program should provide a “continuity of schooling,” where students begin with greater degrees of supervision and advance to more opportunities for independence with a rich program of exploratory experiences.

The program should also ensure a strong student-teacher relationship with the teacher as mentor-advisor, and should be developed around small teams of teachers who get to know the same students better through an interdisciplinary team organization and common planning time.

In the Timberlane study, a procedure was followed in calculating capacity that is similar to that of a high school (although the middle school multiplier was .75 rather than the high school multiplier of .85…due to the unique nature of the educational programs in some middle schools). Middle schools typically are less space-efficient than high schools due to the pattern of scheduling required by a true “middle school model” with a team of students taught by a unique team of teachers; common planning time for teachers on the team; an “Arts rotation” for the students; and student room assignments within limited corridors of the building. See, also, the high school paragraph above, as it contains an added footnote related to middle schools.

C. “THEN-NOW”

The student capacity of a school is directly related to the changing nature of the school’s educational program. Four “Then-Now” charts are included to display the educational program factors which have combined to reduce the student capacity of older school buildings constructed 40-50 years ago. Many schools were designed and built when desks were in straight rows; there were few, if any, Special Education services, and no use of computers. Such buildings served well the programs for which they were designed. Little storage space for educational materials was required. Twenty-First Century schools, however, are expected to provide a broader program to a more comprehensive spectrum of students. Thus, a school which once housed 600 students a generation ago, now may be overcrowded at 500 students. The “Then-Now” charts provide detail in describing this phenomenon, in which new educational programs have decreased the student capacity of older school buildings.

PROGRAM CHANGES = DECREASED BUILDING CAPACITY

ELEMENTARY:	THEN (50 years ago)	NOW
Classrooms	500-600 sq. ft. Desks in rows, no water	1000 sq. ft., learning centers, in-class library, sink & drinking fountain in room (prim. Gr. toilets)
Kindergarten	None, or Half-day, in standard classroom	Full-day, 1200 + sq. ft. toilets sink & drinking fountain, etc.; some preschool
Technology	None	In classrooms and Comp. Lab
Science	In classroom	Separate Science Room
Art/Music	In classroom	Separate Art/Music Rooms; 1200-1500 sq. ft., spec. equip.
Library	Depository for books	Books, computers, media major curr. support; Lib. Sci. instruction

See Rothstein, *The Way We Were: The Myths and Realities of America's Student Achievement (2003);* Tanner and Lackney, *Educational Facilities Planning* (2005); Castaldi, *Educational Facilities 4th edition (1993);* Conrad, *Educational Programs and School Capacity* (1952 Ohio-State University doctoral dissertation)

1

ELEMENTARY (cont'd):	THEN (50 years ago)	NOW
Special Education	Possibly separate classroom, few students in school	Included in regular classes, plus many small instruction rooms; parent conferences required
Handicapped-Accessibility	Little or no accommodations were made	All areas of the school must be handicapped-accessible
Transportation	Some bused, but most children walked or rode bicycles to school	Most children ride buses or are driven to school
Security	Buildings unlocked; not a major concern	Schools are secured; outside phones for parent and emergency calls
Storage	Little needed	Schools use many educational materials; space required

JUNIOR HIGH: THEN (50 years ago) MIDDLE SCHOOL: NOW

Jr. High Departments, Students move throughout building	MS Teams, Students remain in home base wing for most classes
500-600 sq. ft. classrooms	900-1000 sq. ft. student projects, In-class computers/library
Science Labs in one area	Lab in each team area
SPED in separate room, few students	Included in regular classes, small instruction rooms, parent conferences required
Library a depository for books	Books plus computers and other media; major curric. support; Lib. Sci. instruction

HIGH SCHOOL: THEN (50 years ago) NOW

Technology	None	In classrooms and Comp. Lab
Labs	Ind. Arts; Home Ec. Demonstration in Sciences	Tech Ed; Fam/Consumer Sci. Active projects in Sciences
Special Education	Possibly separate classroom, few students in school	Included in regular classes, plus many small instruction rooms
Handicapped-Accessibility	Little or no accommodations were made	All areas of the school must be handicapped-accessible
Library	Depository for books	Books, computers, media Major curr. support; Lib. Sci. instruction
Security	Buildings unlocked; not a major concern	Schools are secured; outside phones for parent and emergency calls
Storage	Little needed	Schools use many educational materials; space required

TIMBERLANE REGIONAL HIGH SCHOOL

Timberlane High School, a single story masonry building, was constructed in 1966. The building had additions in 1980, 1987, and 2000. Four portable classrooms have also been added near the rear of the building. A renovation which created two Science labs took place during the summer of 2008. The high school building has 166,612 square feet. A modern Performing Arts Center with a full auditorium and stage, and an attached drama center with a total seating capacity of 1,090, is located on the campus in close proximity to the high school. The high school building houses 1,578 students in Grades 9-12. The building has 35 regular interchangeable classrooms. Specialized areas have been designated for five computer labs, one of which can be signed out by classroom teachers, three Art rooms, five Physical Education/Health teaching stations, and ten Science rooms/labs. The building also houses a Technical Education room, one Graphic Arts room and two Consumer and Family Science rooms. Two portable classrooms are utilized for instruction in English and Science while two additional portables are used as Special Education instructional spaces. The high school utilizes four instructional spaces in the Performing Arts Center to accommodate the band, chorus, orchestra and drama programs. An additional eight classroom spaces and five small group instruction spaces are used for instruction for Special Education, ELL, OT/PT and tutorial purposes. Using class size numbers provided by the district of 25 students per class, the COC of the school would be 1,564.

The high school is built on a 90 acre campus that includes the middle school and the Performing Arts Center. There is inadequate on-site parking for staff, parents and students. Despite the fact that the District implemented staggered start and end times for the middle and high schools this past September, pick up and drop off issues continue. Because all traffic exits onto Greenough Road from the school property, street and parking lot traffic becomes heavily congested at the beginning and end of the school day.

Timberlane High School is a well-maintained school. However, due to the age of the structure, many of the major systems are described as “tired.” Heat is unevenly distributed throughout the building, especially in the nurse’s office; the lighting fixtures both in and outside the structure are in need of an upgrade; and the windows which have single-pane glass are not energy efficient. The roof is in good condition; however exterior walls are in need of repair.

The high school does not fully meet ADA standards. ADA upgrades regarding some restrooms and signage are needed. Communication in the school takes place via the P.A. system, however, there are some “dead spots.” Classrooms do not have 911 access. Security cameras are in place and monitor movements at the entrance and within the building.

The Library/Media Center is inadequate. It has an insufficient number of work stations and it cannot accommodate more than one class of students at a time. Work space for staff and storage space for Library materials are also limited. Classrooms are inadequate in number and as a result the cafeteria must be used to accommodate study halls. Access to technology within the classrooms is limited, storage space for instructional materials is inadequate and classroom furnishings are described as in “fair condition.” Most Science labs are undersized and unable to accommodate 21st Century needs. Similar deficiencies exist within the Graphic Arts and Family and Consumer Science instructional areas. These limitations impede the full implementation or expansion of these programs.

Administrative office spaces are adequate, however, conference and storage space for the main office is lacking. The guidance and psychologist’s offices are located near the main entrance adjacent to the administrative suite and they include a reception area and work spaces. The nurse’s office is near the main office in close proximity to the main exit. The office is small and cramped. Privacy and ample storage space are lacking. Teacher work space is severely limited and inadequate. The teacher lunch room is small and provides limited seating for the faculty. There is no sink in the room.

The high school has one gymnasium area with two teaching stations. Boys and girls locker rooms are available, however, they are small, outdated and in need of upgrading. Weight and exercise rooms are located near the gym. Field space adequately accommodates the high school Physical Education and athletic programs. However, some of the fields are in need of major renovations.

The auditorium which is located at the Performing Arts Center has a wide stage, dressing rooms and ample storage space. Audio and lighting equipment is in good condition. The seating capacity, including the adjacent Drama Center, is 1,090. The cafeteria, which has a capacity of 320, is unable to adequately accommodate the student population. There are six lunch waves and three serving stations. Storage is inadequate and the kitchen equipment is outdated.

To address the existing deficiencies with regard to the lack of adequate space for Science labs, study halls, the Home Tech area and the TV production area, it would be necessary to take seven classrooms off-line. Taking the portable classrooms off-line would require an additional four classroom spaces. Accommodating needs for additional teacher, departmental and administrative work, conference and storage space would require that an additional eight classrooms be taken off-line. The POC of the school would then be 953. (This does not address capacity issues in the cafeteria and the Library.)

FACILITY PROFILE - HIGH SCHOOL

Name: **Timberlane Regional High School**	Grades: **9-12**	Reg. enr.: **1,578**	Spec. Ed. enr.: **Approx 284**
Year of Construction: **1966**	Year of Additions: **1980, 1987, 2000**	Sq. ft.: **166,612**	Acres: **90 Acres–shared with M.S.**
Optimum number of pupils per class: **25**		Number of interchangeable general classrooms: **35**	

In addition, does the School have dedicated space for (indicate number of rooms in the appropriate box):

	Full-size room	Conference-size room	Space shared with	No. of student stations	Comments (if desired)
Art	3			75	
Business-Typing/Comp.	5			92	1 sign out in Library
I.A. Foods/Sewing	2			35	In need of update
Construction/Manufacturing/Elect	1			15	
Mech. Draw/CAD/Graphics	1			25	Needs update
Drama	1		M.S.	25	Amphitheater in P.A.C.
Band/Chorus/Orchestra	3		M.S.	100	Performing Arts center – w/M.S.
TV studio		1			Recording room – no studio
Physical Education	1	2		90	Lg. gym, Ex., Sm. gym, Wt/ex.rm.
Health Room	1			25	
Science Labs/Rooms	11			264	2 new and 1 in portable c.r.
Special Needs cr's	9	5			Pull out learning centers/sm. grp.
Portable classrooms	4				1 regular*, 1 Sc. Lab**, 2 Sp.Ed.***
Psychologist		2			Shared office space
Guidance/Testing		6			Conference/meeting space limited
OT/PT	1				Adequate space
Auditorium	1		M.S.	1090	P.A.C. Capacity includes drama area
Cafeteria	1			275-320	6 waves – 3 lines – inadq. storage
Library	1			30	Small, limited storage, comp. rm.
Nurse's Office		1			Lacks privacy, storage
Administrative Offices		6			Limited – no conference area
Teachers' Room – lunch		1			Inadequate – 3 tables, no sink
Teachers' Workroom		1			Small inadequate

Current Operating Capacity: 1,564 Planned Operating Capacity: 953****

(See next page for details on C.O.C. and P.O.C. computation)

* Included with interchangeable count

** Included with Science room count

*** Included with Special Education room count

**** Does not address capacity issues in the cafeteria or Library

TIMBERLANE REGIONAL HIGH SCHOOL
CURRENT/PLANNED OPERATING CAPACITY

Current Operating Capacity - COC	**Number of Rooms**	**Student Stations**	**Total**
Room Description			
Regular Interchangeable Classrooms	35	25	875
Art Rooms	3	25	75
Business / Computer	4	23	92
Foods and Consumer Science	2	1 x 20 1 x 15	35
Tech Ed.	1	15	15
CAD / CAM Graphics	1	25	25
Drama – in P.A.C.	1	25	25
Band / Chorus / Orchestra – in P.A.C.	3	25	75
Physical Education / Health	4	115 (Includes Weight and Exercise Rooms)	115
Science Rooms / Labs	11	24	264
Total		Student Stations	1,596
Current Operating Capacity - COC		1,596 x .98 Space Utilization Factor	**1,564**
Planned Operating Capacity - POC			
Eliminate 4 portable classrooms	4 rooms off-line	-25	-100
Remove study halls from cafeteria	1 room off-line	-25	-25
Increase Science lab sizes	3 rooms off-line	-25	-75
Create teacher work space	1 room off-line	-25	-25
Add administrative conference area and teacher lunch space	1 room off-line	-25	-25
Add departmental office space	1 room off-line	-25	-25
Add storage space for nurse and instructional materials	1 room off-line	-25	-25
Expand home tech area	1 room off-line	-25	-25
Additional meeting and work areas for core disciplines	4 rooms off-line	-25	-100
Add adequate area for TV studio	2 rooms off-line	-25	-50
Total		Student Stations	-475
Planned Operating Capacity - POC		1,596 - 475 = 1,121 1,121 x .85 = 953 Space Utilization Factor	**953** (Does not address capacity issues in cafeteria and Library)

Undersized Lab

Nurse's Office Lacks Privacy

Inadequate Locker Rooms

Cafeteria Undersized

Restrooms Need Update

Storage Shortage

Portable Classroom

Traffic Congestion

TIMBERLANE REGIONAL MIDDLE SCHOOL

Timberlane Middle School, a single story masonry building, was constructed in 1973. The building had additions in 1984, 1996, and 2000. Renovations took place in 2007 and during the summer of 2008. The middle school building has 135,000 square feet. A modern Performing Arts Center with a full auditorium and stage, and an attached drama center with a total seating capacity of 1,090, is located on the campus in close proximity to the middle school. The middle school building houses 1,108 students in Grades 6-8. The building has 44 regular interchangeable classrooms. Four additional classrooms are equipped as Science labs. Specialized areas have also been designated for four computer labs, one of which can be signed out by classroom teachers, three Art rooms, and one gymnasium with three Physical Education teaching stations. The building also houses two Consumer and Family Science rooms and two Music rooms. The middle school utilizes instructional spaces in the Performing Arts Center to accommodate additional Music classes. An additional five classroom spaces and five small group instruction spaces are used for Special Education and OT/PT and tutorial purposes. Using class size numbers provided by the district of 25 students per class, the COC of the school would be 1,355.

The middle school is built on a 90 acre campus that includes the high school and the Performing Arts Center. There is inadequate on-site parking for staff, parents and students. Despite the fact that the District implemented staggered start and end times for the middle and high schools this past September, pick up and drop off issues continue. Because all traffic exits onto Greenough Road from the school property, street and parking lot traffic becomes heavily congested at the beginning and end of the school day.

Timberlane Middle School is a well-maintained school. However, due to the age and original design of the structure the building is in need of major renovations. Hallways are narrow and congested. Although parts of the building are air conditioned, the classrooms on the inside corridors are poorly ventilated and become uncomfortably warm in the spring and early fall. Ceilings are in need of replacement and the windows which have single-pane glass are not energy efficient. The roof above the gymnasium has several leaks.

The middle school does not fully meet ADA standards. ADA upgrades regarding some restrooms and signage are needed. Communication in the school takes place via the P.A. system which is described by administration as "old and tired." Classrooms do not have 911 access. Security cameras are in place and monitor movements at the entrance and within the building.

The Library/Media Center is located in an open space area and this creates acoustical problems. The space can only accommodate one class at a time and this causes scheduling issues. Work space for staff and storage space for Library materials are also limited. Many middle school classrooms are undersized (less than 900 square feet) and furnishings, technology access and storage spaces for instructional materials are viewed as inadequate. Many classroom doors cannot be locked and this creates a safety issue. Student lockers are obsolete. The four Grade 8 Science labs are undersized and in need of reconfiguration and equipment updates. There are no specialized Science facilities for students in Grades 6 and 7 and this compromises full program implementation. The Family and Consumer Science area is small and in need of an update. There is a shortage of classrooms for Foreign Language instruction and since September, due to a shortage of instructional space, a classroom has been located in the former teachers' room adjacent to the cafeteria. Scheduling issues also occur as a result of the fact that the middle school has to share Performing Arts Center Music spaces with the high school.

Administrative office spaces are adequate, however, conference and storage space for the main office is lacking. The guidance and psychologists' offices are located near the main entrance within the administrative suite. The nurse's office which was renovated during the summer of 2008 is near the main office in close proximity to the main exit. Since the renovation, the office provides increased privacy and storage capacity. Teacher work space is severely limited and inadequate. The teacher lunch room is a small, converted closet and provides limited seating for the faculty. There are no designated team meeting areas.

The middle school has one gymnasium area with three teaching stations. However, the space is crowded and does not adequately accommodate three classes.

Boys and girls locker rooms are available. Field space for school activities is insufficient and the field behind the middle school is in poor condition.

The auditorium which is located at the Performing Arts Center has a wide stage, dressing rooms and ample storage space. Audio and lighting equipment is in good condition. The seating capacity, including the adjacent Drama Center, is 1,090. The cafeteria, which has a capacity of 200, is unable to adequately accommodate the student population. There are 12 staggered lunch waves and three serving stations. Storage in the kitchen area is limited.

To address the existing deficiencies with regard to the lack of adequate space for Science labs, the Family and Consumer Science area, the Library and the Foreign Language program it would be necessary to take seven classrooms off-line. Two additional rooms would be required to expand the Physical Education instructional area. Addressing the need for additional conference, work and storage space would require an additional six and a half classroom spaces. The POC of the school would then be 845. (This does not address capacity issues in the cafeteria.)

FACILITY PROFILE – MIDDLE SCHOOL

Name: **Timberlane Regional Middle School**	Grades: **6-8**	Reg. enr.: **1,108**	Spec. Ed. enr.: **Approx 244**
Year of Construction: **1973**	Year of Additions: **1984, 1996, 2000**	Sq. ft.: **135,000**	Acres: **90 Acres – shared with H.S.**
Optimum number of pupils per class: **25**	Number of interchangeable general classrooms: **48**		

In addition, does the School have dedicated space for (indicate number of rooms in the appropriate box):

	Full-size room	Conference-size room	Space shared with	No. of student stations	Comments (if desired)
Art	3			75	
Computer	4			75	1 sign out
Family and Consumer Science	2			50	In need of update
Drama	*		H.S.		Amphitheater in P.A.C.
Band/Chorus	2			100	Plus P.A.C. w/H.S.
Physical Education	1			90	3 teaching stations at 30 - crowded
Science Labs	4			100	8^{th} Gr. only- Included w/Gen. C.R.
Special Needs cr's	5	5			
Reading		3			
Psychologist		3			Shared office space
Guidance/Testing		3 + 2			Conference/meeting space limited
OT/PT		1			Adequate space
Auditorium	*		H.S.		Performing Arts Center
Cafeteria	1			200	12 waves – staggered – 3 lines
Library	1			30	Small, limited storage, open space
Nurse's Office		1			Adequate
Administrative Offices		3			Limited – no conf. area
Tchrs' Work room – lunch room		1			Inadequate, small

Current Operating Capacity: 1,355 Planned Operating Capacity: 845**

* Included in high school tabulation
** Does not address space issues in cafeteria

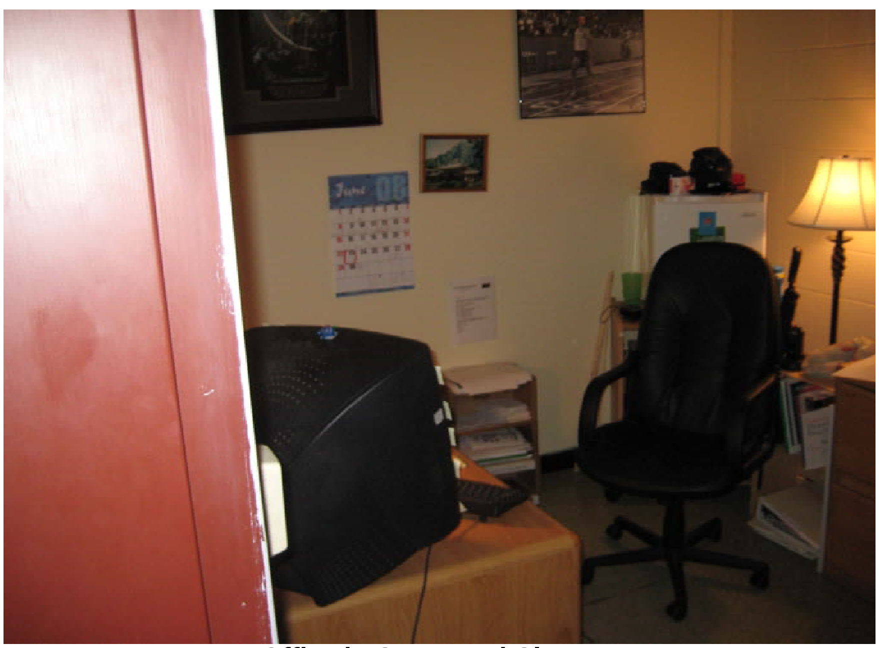
TIMBERLANE REGIONAL MIDDLE SCHOOL
CURRENT AND PLANNED OPERATING CAPACITY

Current Operating Capacity - COC	**Number of Rooms**	**Student Stations**	**Total**
Room Description			
Interchangeable classrooms	48	25	1,200
Art	3	25	75
Computer instruction	3	25	75
Family and Consumer Science	2	25	50
Music	2	25	50
Physical Education	1	90	90
		Student Stations	1,540
Current Operating Capacity - COC		1,540 x .88	**1,355**
Planned Operating Capacity - POC	**Number of Rooms**	**Student Stations**	**Total**
Expand Science instruction and storage areas	3 rooms off-line	-25	-75
Expand Library space and storage capacity	2 rooms off-line	-25	-50
Expand gym area	2 rooms off-line	-25	-50
Provide an additional FAC instructional space	1 room off-line	-25	-25
Create team meeting and conference areas	4 rooms off-line	-25	-100
Provide adequate teachers' lunch room and prep room	1 room off-line	-25	-25
Provide administrative conference space	.5 room off-line	-25	-13
Provide additional storage space	2 rooms off-line	-25	-50
Designated space for Foreign Language Instruction	1 room off-line	-25	-25
Total		Student Stations	-413
Planned Operating Capacity – POC with Program Expansion		1,540 - 413 = 1,127 1,127 x .75 = 845	**845** (Does not address capacity issues in cafeteria)

Open Library Area

Science Facilities in Need of Update


Small Group Instruction in Converted Closet


Office in Converted Closet

Storage Issues

III. STATEMENT OF THE PROBLEM

NEAR-TERM

- Need to develop a long-range plan for PK-12 facilities and educational program planning
- Need to consider purchase of additional land at the middle school/high school site to expand field space and provide for a second avenue of egress from the school campus
- Need to continue efforts to improve building security

LONG-TERM

- Need to rehabilitate/replace school spaces which do not support 21st Century educational programs
- Need to increase high school and middle school capacities and address current inadequate instructional spaces

IV. ALTERNATIVE SOLUTIONS

As indicated in the descriptions of the individual schools, the Timberlane High School and Middle Schools are over their capacity, unable to fully meet 21st Century instructional needs and in need of major structural upgrades.

The three options presented in this Report assume:

1. The Timberlane District will consider the NESDEC Report, and decide upon a Long-Range School Facilities Plan
2. There will be continuing support for maintenance and asset protection
3. Progress regarding handicapped-access will be made
4. Continuing attention will be given to class sizes

Other potential options, including moving Grade 6 to the elementary schools, realigning Grade 5 to a new middle school and purchasing an additional school site to accommodate either a new high school or middle school were reviewed by the NESDEC Team. However, they were deemed to be unsuitable due to factors such as excessive costs, inefficient or inappropriate use of school facilities or the inability of the potential option to sufficiently meet 21st Century instructional needs.

On the following pages, the NESDEC Project Team offers alternative solutions to the long-range problems previously identified. Each option describes the solution to the problem and lists some advantages and disadvantages. The options should be discussed, compared, and analyzed by local officials and staff more thoroughly than we have done in this Report. Consider, for example, refinements, possible different combinations, additional advantages and disadvantages.

When we refer to "major renovation/upgrade" (or redesign) of an existing building, we typically use the rule-of-thumb of 75% of the cost of new construction. This usually involves a gutting of the entire building, redesigning interior spaces, and reconstruction of the building, including replacement of the major building sub-systems (HVAC, lighting, plumbing, windows, roofs, electrical, etc.). The building then should be in a "like-new" condition, upgraded to current program space and code standards, and good for another 25-35 years of service. Sometimes, if a building presents unique problems or is in particularly poor condition, we estimate the renovation at more than 75% of the cost of new construction. **If the building will be only partially renovated, or if it is in better-than-average condition for its age, we estimate the renovation at 50% of the cost of new construction.** When we refer to "minor renovations," it is usually for one or more of the following reasons:

- The building's original construction was of very high quality and it has been exceptionally well-maintained.
- The building needs some minor redesign and reconstruction of a few key areas only or replacement of only one or two building sub-systems. Or, portions of the building have been modernized recently.
- The building is of such age and design that it should be discontinued as an active school building in the not-too-distant future, but some minimal renovation/replacement work is needed to keep it in service for the next several years.

There are several stages of cost estimation for school building construction work. During the Planning Stage (such as this study), gross cost estimates are made based on the number of pupils, either the State Department of Education's (SDE) maximum square footage allowance per pupil or the estimated cost per pupil based on recent school construction cost data. The result is a reasonable cost figure to use for planning purposes for each option under consideration.

Once a course of action has been decided upon and the architect has developed **Preliminary Plans**, a revised cost estimate can be secured.

Upon completion of the **Schematic Design** phase, the architect often will have a professional construction cost estimation company do a more sophisticated cost estimate. The same is often done prior to sending out the final "bid set" (Final Construction Plans and Specifications) so as to establish a baseline against which to assess the bids on the project.

In essence, these are all "cost estimates," becoming more refined as the planning process unfolds. The final cost of the project will not be known until bids are opened and the construction actually completed.

Thus, using the New Hampshire state information and recent construction experience is perhaps the best cost estimation criteria for planning purposes at this preliminary stage of the building planning process. The areas needing to be reconfigured, or possible projects to be accomplished, can be found in the school descriptions in the School Capacities section of this Report.

If it will be two-three years before the project is bid, two-three years of projected inflation would need to be added to the projected cost estimates. At present, school construction costs in New Hampshire are escalating at about 8% per year.

One final word on costs: The Timberlane RSD may be entitled to State reimbursement on the cost of an approved school building project. Thus, the estimated cost of building construction should be reduced by the amount of State reimbursement to arrive at the actual net cost to the Timberlane RSD after State reimbursement. This net cost would be spread out over the 20 years of the bond issue.

OPTION I

Description:

- Construct a new 1,500 student high school on the existing 90 acre high school/middle school site
- Relocate Grades 6-8 to the existing (present) high school building
- Renovate/add to the present high school building to accommodate the middle school model and to eliminate existing educational and structural deficiencies in the building
- Use the existing middle school building for swing space during the renovation of the present high school
- After the renovation of the existing high school building, consider alternatives regarding the disposition of the middle school building
- Consider the purchase of additional land to provide compensation for lost field space and to allow for a second avenue of egress from the school campus
- Continue the Grade 6-12 use of the modern Performing Arts Center

Configuration:

PK-5, 6-8, 9-12

Advantages:

- Provides a modern high school facility capable of addressing 21st Century educational needs and instructional techniques
- Reassigns the present Timberlane Middle School to another use
- Eliminates problems created by the severe overcrowding situation at the high school and middle school
- Eliminates four portable classrooms at the high school
- Renovates and converts the existing high school into a middle school facility providing additional instructional, storage and work space for the improved implementation of the middle school model and curriculum
- Improves overall building security at the high school/middle school levels
- Provides adequate administrative work and conference space at the high school/middle school levels

- Addresses traffic problems on the campus by providing for a second entrance/egress option
- Addresses current ADA inadequacies at the present high school building
- Provides additional cafeteria and Media Center space at the present high school building to accommodate the middle school population
- Upgrades the outdated HVAC and electrical systems at the present high school building
- Continues use of the modern Performing Arts Center
- Provides swing space for middle school students during the renovation of the existing high school building
- Saves on the substantial maintenance/repair costs associated with continued use of the present middle school building

Disadvantages:

- Construction activity will cause further traffic congestion and a disruption of activities at the high school/middle school site (the construction impact could be mitigated if the site is expanded prior to the start of construction)
- With the construction of a new high school and the renovation/expansion of the present high school building to accommodate the middle school, field space at the site will be reduced (expansion of the site could lesson the impact of building expansion on the availability of field space)
- Students will continue to travel outside of the main building in order to attend classes in the Performing Arts Center
- The District will have to determine an alternative for the disposition of the present middle school building after the renovated high school is converted to a middle school
- Option I is the most expensive of the three options

OPTION II

Description:

- Construct an 1,100 student middle school on the existing 90 acre high school and middle school site
- Renovate and add to the present high school building to accommodate space needs and to eliminate existing educational and structural deficiencies in the building
- Use part or all of the existing middle school building for swing space during the renovation of the present high school
- After the renovation of the existing high school building, consider alternatives regarding the disposition of the middle school building
- Consider the purchase of additional land to provide compensation for lost field space and to allow for a second avenue of egress from the school campus
- Continue the Grade 6-12 use of the modern Performing Arts Center

Configuration:

PK-5, 6-8, 9-12

Advantages:

- Provides a modern middle school facility capable of addressing 21st Century educational needs and instructional techniques
- Reassigns the present Timberlane Middle School to another use
- Eliminates problems created by the severe overcrowding situation at the high school and middle school
- Eliminates four portable classrooms at the high school
- Renovates and adds to the existing high school facility providing instructional, storage and work space for the improved implementation of the high school's present curriculum
- Provides additional cafeteria and Media Center space at the high school building
- Improves overall building security at the high school/middle school levels
- Provides adequate administrative work and conference space at the high school/middle school levels

- Addresses traffic problems on the campus by providing for a second entrance/egress option
- Addresses current ADA inadequacies at the high school building
- Upgrades the outdated HVAC and electrical systems at the high school building
- Continues use of the modern Performing Arts Center
- Provides swing space for high school students during the renovation of the high school building
- Saves on the substantial maintenance/repair costs associated with continued use of the present middle school

Disadvantages:

- Although Option II provides for adequate capacity to implement the existing high school program, it does not provide for the incorporation of expanded Culinary Training, Child Care, and Computer Technology Programs
- Construction activity will cause further traffic congestion and a disruption of activities at the high school/middle school site (the construction impact could be mitigated if the site is expanded prior to the start of construction)
- With the construction of a new middle school and the renovation/expansion of the present high school building, field space at the site will be reduced (expansion of the site could lesson the impact of building expansion on the availability of field space)
- Students will continue to travel outside of the main building in order to attend classes in the Performing Arts Center
- The District will have to examine alternatives for the disposition of the present middle school building after the new middle school is constructed and the high school is renovated
- Option II is more expensive than Option III

OPTION III

Description:

- Renovate and add to the present high school building to accommodate space needs and to eliminate existing educational and structural deficiencies in the building
- Renovate and add to the present middle school building to accommodate the middle school model and to eliminate existing educational and structural deficiencies in the building ***(please note: a preliminary report update from the architectural firm of Lavallee and Brensinger, received by NESDEC on 9/28/08, casts doubt on the feasibility and cost effectiveness of renovating the middle school)***
- Research available local and regional locations, that would provide temporary swing space to be used when the high school and middle school are renovated
- Consider the purchase of additional land to provide compensation for lost field space and to allow for a second avenue of egress from the school campus
- Continue the Grade 6-12 use of the state-of-the-art Performing Arts Center

Configuration:

PK-5, 6-8, 9-12

Advantages:

- Eliminates problems created by the severe overcrowding situation at the high school and middle school
- Eliminates four portable classrooms at the high school
- Addresses traffic problems on the campus by providing for a second entrance/egress option
- Renovates and adds to the existing high school facility providing additional instructional, storage and work space for the improved implementation of the high school's present curriculum
- Renovates and adds to the existing middle school facility providing additional instructional, storage and work space for the improved implementation of the middle school model and the present curriculum

- Addresses current ADA inadequacies at the high school and middle school buildings
- Provides additional cafeteria and Media Center space at the high school and middle school buildings
- Upgrades the outdated HVAC and electrical systems at the high school and middle school buildings
- Improves overall building security at the high school/middle school levels
- Provides adequate administrative work and conference space at the high school/middle school levels
- Continues Grade 6-12 use of the modern Performing Arts Center

Disadvantages:

- Due to the need for extensive renovations and additions at the high school and middle school buildings, it would be imperative that a facility or facilities be found to temporarily provide swing space to accommodate large numbers of students during the conduct of renovation/addition projects
- It is unlikely that any off-campus swing space would be able to fully accommodate curriculum program implementation needs
- Temporarily assigning high school or middle school students to off-campus locations would present transportation, scheduling and staffing challenges and potentially increase operating costs
- Although Option III provides for adequate capacity to implement the existing high school program, it does not provide for the incorporation of expanded Culinary Training, Child Care, and Computer Technology Programs
- Construction activity will cause further traffic congestion and a disruption of activities at the high school/middle school site (the construction impact could be mitigated if the site is expanded prior to the start of construction)
- With the renovation/expansion of both the high school and middle school buildings, field space at the site will be reduced (expansion of the site could lesson the impact of building expansion on the availability of field space)
- Students will continue to travel outside of the main building in order to attend classes in the Performing Arts Center

- Although the high school and middle school buildings would be updated, original design and site limitations may limit full implementation of 21st Century instructional programs and techniques

V. CRITERIA FOR EVALUATION OF OPTIONS

To assist the Timberlane RSD in making decisions as to the best way to proceed in developing a Master Plan for school facilities, the NESDEC Project Team suggests the application of the following criteria to the options presented. **In developing a Long-Range Plan, the Timberlane District may wish to "mix-and-match" among the options.**

Evaluation Criteria for Long-Range Planning Options

1. **Solves the Problems as Defined**
   How well does the option solve the problems as defined? Does it solve the problems for the long-term, or is it merely a quick fix or "band aid" approach?
2. **Provides Long-Term Flexibility**
   Does the option provide long-term flexibility? Enrollment projections are just that, projections, they are not guarantees. Whatever the School Board chooses to do, it should take into account the possibility of a 10% swing either way in terms of enrollment at all levels. In other words, the School Board should be prepared to respond to the questions: **"How will the space be used if 10% fewer students materialize?"** and **"How will the space be provided if 10% more students materialize?"**
3. **Provides for Program Improvement**
   Does the option improve the educational program (or is it at least program-neutral)? It is not acceptable to provide additional program spaces for one group of students at the expense of the program of another. Does it assure equity for all students with respect to program and curriculum consistency?
4. **Provides for Minimum Disruption**
   What is the "disruption factor" in the options? NESDEC was asked where students might be relocated during any school renovation projects. First, we are not aware of any off-site school "swing space" available on a temporary basis. Second, smaller projects can be timed to occur during the summer vacation (with materials delivered in advance), or in May through October when students are more often out-of-doors. More important, however, is the fact that some school

architects and school construction firms specialize in providing for school children to be safe and learning disrupted as little as possible. There should be stated criteria in any Request for Proposals issued by the Timberlane RSD. A second "disruption factor" to be considered is lead time for planning. Whichever plan is chosen, many steps are required in implementation. Parents and teachers need time to consider the nature of the PK-12 system problems (as opposed to the portion of the problem/change that immediately affects "me"). Parents and teachers also will need time to attend meetings or professional training. Detailed plans for moving books, equipment, and ordering new items are important. What makes sense, given adequate time to implement, may be less-than-successful if on a timetable which is rushed.

5. **Is Financially Responsible**

   Is the option financially responsible? Does it provide the "most for the least?" The best approach need not be either the most expensive or the least expensive option. The key word is "responsible." While a less expensive option may have immediate appeal, it may end up costing the district more money over the long term.

6. **Is Consistent with School Board Policy/Guidelines**

   The option should support and enhance the community's educational programs as defined by School Board guidelines and policy. For example, if the option were to call for raising basic class sizes to 35 pupils, it would create a major change and disruption in educational programming and School Board policy/guidelines.

VI. SPECIAL CONSIDERATIONS

A. FULL-DAY KINDERGARTEN AND EARLY CHILDHOOD EDUCATION

B. WHY INVEST SCARCE DOLLARS IN SCHOOL BUILDINGS?

C. SITE SIZE AND SELECTION CRITERIA

VI. A. FULL-DAY KINDERGARTEN AND EARLY CHILDHOOD EDUCATION

The "behavioral" or other Early Childhood Special Needs classes need to be evaluated periodically to insure that the programs and available resources are the most appropriate means of meeting the needs of students. Some districts, when tough financial times occur, consider restricting budgets in Early Childhood education. This is understandable as strong Early Childhood programs were unknown a generation ago. Yet the evidence is massive that such programs are the bedrock for later school success. One such example is North Smithfield, Rhode Island which has had a strong Early Childhood program (full-day Kindergarten for all, plus an integrated Preschool) for six years. The District already is experiencing almost no need for students to repeat Kindergarten or to enter a Readiness program, as well as much stronger success in Grade 1 and 2 Reading, considerably fewer high-cost referrals to Special Education, and cost-containment in its overall budget. Other districts across New England are achieving similar results.

Over the last three decades, many studies have found that a high quality Early Childhood experience boosts both later school achievement and social adjustment, reducing the likelihood of grade retention or placement in Special Education and increasing the probability of graduation from high school. Research also has shown that the negative effects of poverty can be reduced by participation in high quality Early Childhood education programs. "All-Day Kindergarten" (Clark and Kirk, 2000) indicates a long-lasting benefit for children in quality full-day Kindergarten programs. In the early 1980's, only about 30% of U.S. Kindergarten children attended full-day programs; by 1993 the number had risen to 54%; currently it is about 60%…although New England lags behind the national average in this matter. In facilities planning, some states now require communities to plan sufficient space for full-day Kindergarten and for Preschool when requesting grant monies for major renovations or for new elementary schools. *"Securing Our Future" (MA Department of Education, 2001) notes that 65% of infants and toddlers spend eight hours or more per day in daycare…and would benefit from quality educational programs.*

Dramatic evidence of vital importance to Early Childhood education has come from the field of neuroscience. We now know that early experience has a direct influence on the connective pathways that are established in the brain during the early years of life. The quality of a child's early experiences not only affects his/her comfort and sense of security, it actually affects his/her brain development and later ability to learn and to reason. Research studies document that early identification and early intervention with respect to cognitive, developmental, physical, social and emotional problems in young children, birth to six or seven years of age, provides substantial long-term positive impact on the overall development of children. More recently, studies have demonstrated that normally-developing children benefit substantially from sound early developmentally-based educational programs.

In short, formal school-based early childhood programs enhance the development of **all** children and significantly reduce the incidence of cognitive/developmental psycho-emotional difficulties through the pre-adolescent and adolescent years. There is an economic advantage to the school, as well, in terms of cost-avoidance and the distress that unaddressed problems of this nature create. The most recent evaluation of the Perry Preschool/High Scope Study (which documents the participants lives at age 27, compared with a control group who did not attend Preschool) shows that **for every $1 invested in high quality Preschool programs, over $7 is saved in later remedial education services, criminal justice spending, and welfare costs** (Schweinhart et al. 1993). A study of 17,600 Philadelphia school children further supports the academic and financial benefits of full-day Kindergarten (Andrea de Gaudio-Weiss, American Educational Research Association, April, 2002). Recently, economists have noted the long-term financial savings of providing Early Childhood programs, a strong argument for investing in accessible, comprehensive early care and education for all families. The National Committee for Economic Development, a group of 250 leaders in business, industry, and education, has published <u>The Unfinished Agenda: A New Vision for Child Development and Education</u> which strongly advocated full-day Kindergarten and recommended PK educational programs. James Heckman, a Nobel Prize-winning economist, advocated for full-day Kindergarten and strong Preschool programs in "Preschool for All: Investing in a Productive and Just Society" (2004). Economist Arthur Rolnick made similar points in a study for the Minneapolis Federal Reserve Bank (2004). "Exceptional Returns: Economic, Fiscal and Social Benefits of Investment in Early Childhood Development" by economist Robert Lynch (2004) finds such programs pay for themselves, generating $2 in returns to school taxpayers for every $1 invested…and the total benefits to society exceed 8 to l. **A compelling case regarding strong programs for three-five-year-olds is made by the National Governors Association Task Force on School Readiness; see "Building the Foundation for School Readiness" (2005) available on-line at www.nga.org/cda/files/0501TaskForceReadiness.pdf.**

In light of this body of research and the current developments in the field, the Timberlane RSD would be serving its students (and its taxpayers) well by continuing to emphasize school readiness through full-day Kindergarten and additional integrated Preschool programs.

VI. B. WHY INVEST SCARCE DOLLARS IN SCHOOL BUILDINGS?

Frequently NESDEC is asked by a District: "Why should we spend dollars on school facilities when we are finding it difficult to afford enough books and adequate numbers of teachers?" *"Growth and Disparity: A Decade of U.S. Public School Construction"* by the 21st Century School Fund (October 2006) addresses these questions at this critical time when municipal and school budgets are as tight as any in recent memory.

Education Quality and the Condition of School Buildings

Research has confirmed what many educators have held as common sense – the quality of a school facility has an impact on students' experiences, and ultimately on their educational achievement. The research on school building conditions and student outcomes finds a consistent relationship between poor facilities and poor performance: **When school facilities are clean, in good repair, safe, and designed to support high academic standards, there will be higher student achievement, independent of student socio-economic status**. There is growing evidence supporting these findings:

- The cognitive requirements for learning and teaching – motivation, energy, attention, hearing, and seeing – are affected by the physical surroundings where they take place (Schneider 2002);
- The amount of natural light, the indoor air quality, the temperature, and the cleanliness of schools and classrooms all impact student learning (Earthman 2004);
- Overcrowded schools lead to higher absenteeism rates for both students and teachers and have detrimental effects on children's ability to learn and perform well (PolicyLink 2005);
- Poor building conditions greatly increase the likelihood that teachers will leave their school – a troubling fact given the need for more and better teachers in the most disadvantaged schools (Buckley et al. 2004).

We know that if school facilities are unsafe, unhealthy and unable to support technology for the delivery of curriculum…or to provide the support services needed for students to succeed, minority and low-income children are further disadvantaged.

Community Vitality and School Buildings

Research also has confirmed that public schools affect communities and their economic strength (Weiss 2004). Schools influence the reputation, quality of life, and vitality of neighborhoods. Conversely, the quality, vitality, and support of a neighborhood affects local schools. Because school facility improvements mean an influx of capital dollars in a neighborhood, there is great potential to positively impact that community. Evidence increasingly supports the following:

- School quality has a direct and positive impact on residential property values (Kane et al. 2003);
- School quality helps determine a community's quality of life and can affect the ability of an area to attract businesses and workers (Salveson and Renski 2002);
- Investments in the construction and maintenance of school facilities inject money into local economies through job creation and supply purchases (Economics Center for Education and Research 2003);
- New or well-maintained school facilities can help revitalize distressed neighborhoods (Local Government Commission 2002);
- The activities that occur in and around school buildings can help build neighborhood social capital and affect student achievement (Blank et al. 2003).

VI. C. SITE SIZE AND SELECTION CRITERIA

Because of the need to consider which schools to renovate extensively and which to possibly close, as well as the long-term need to consider building a new school, the Timberlane RSD will need to evaluate its school sites. It is beyond the scope of this Report for NESDEC to attempt to identify potential construction sites, however, we can suggest a planning process that has worked well in many communities. The NESDEC Project Team urges the District to appoint a special School Site Selection Committee (if the School Board determines that one is needed) with a view toward evaluating school sites as soon as is feasible. A good school site will accommodate the school building itself, a safe traffic pattern with separated routes for buses, staff cars, parent cars, service vehicles, bicycles and pedestrians. Community uses, other than school uses, should be considered. The site should provide adequate parking for staff, volunteers, and visitors. The site also requires adequate field space to accommodate physical education, athletic and community recreational programs.

General Site Selection Criteria

Criteria adopted from Standards and Site Standards developed by
The Council of Educational Facility Planners, International (CEFPI)

I. Size – The site should be of sufficient size to accommodate the ultimate (maximum) building capacity and any special features or community requirements. The recommended acreage is large because it considers fields and play space. Conservation and environmental approvals must be obtained and filed with the appropriate state agencies as part of the application process.

New Hampshire Site Guidelines*		**CEFPI**
Elementary	5-10 Acres + 1 acre for each 100 pupils	10 Acres + 1 A/100
Middle	10-20 Acres + 1 acre for each 100 pupils	20 Acres + 1 A/100
High School	15-30 Acres + 1 acre for each 100 pupils	30 Acres + 1 A/100

* New Hampshire Department of Education, Manual for Planning and Construction of School Buildings (2006) and Council of Educational Facility Planners, International (CEFPI)

II. Location/Shape

- Easily accessible/located for present and future population.
- Walking distance: 1 mile elementary; 2 miles secondary.
- Bus riding time: 30 minutes elementary; 60 minutes secondary.
- Removed from undesirable business/industry/heavy traffic…safe/healthful; no toxic waste/pollution.
- Check zoning to avoid future commercial/industrial development near the school.
- Elementary schools located off main roadways; secondary, especially high schools, located near main roadways.
- Site should be square or round, not a long oblong one, or a chopped-up and divided site.

III. Topography

- Elevation and contours to insure good drainage.
- Avoid rock outcroppings and ledge.
- Avoid extensive wetlands and sub-surface water conditions.
- Is site landscaped or is it capable of supporting a wide variety of tree/plant life?
- Will the site support a sizeable septic system if not serviced by municipal sewers?

IV. Instructional Needs

- Sufficient space for outdoor Physical Education classes.
- Sufficient space for informal play fields (before/after school and recess).
- Some (at least minimal) outdoor Science teaching stations and/or nature trails.
- Sufficient area for one or more formally equipped playground area(s) for elementary schools.

V. Utilities

- Located on-site or on the roadway leading to the site.
- Estimate costs of bringing utilities on-site if the site does not presently have them (be especially aware of the need and costs for blasting through existing ledge to bring utilities onto a site, or extensive distances from the nearest utilities to the site).
- Identify location of existing storm/sanitary sewers on or contiguous to the site.

VI. Road/Sidewalks/Parking

- Site should be able to accommodate reasonable separation of vehicles and pedestrians.
- Service vehicles and buses should be separated from parent drop off/pick up roads and areas. Staff parking should be separated from all other vehicular traffic and located near staff entrance.
- Pedestrian and bicycle walkways/bikeways should be separate from and avoid hazardous crossings of any vehicular traffic.
- There should be one parking space for each anticipated staff member; approximately 50% of 11th and 12th Grade pupils may drive cars; additional space for parent/public parking as determined necessary for elementary, middle, high school.
- Each parking space should be approximately 300 square feet; 2% should be for handicapped parking with curb cuts/ramps for handicapped-access.
- Playgrounds/athletic fields separated from roads for safety reasons.

VII. Acquisition and Costs

- Site is owned by the community and can be transferred to the school/system.
- Site can be purchased at or below market value cost.
- Site can be purchased with the cooperation of owner and abutters, without eminent domain proceedings.

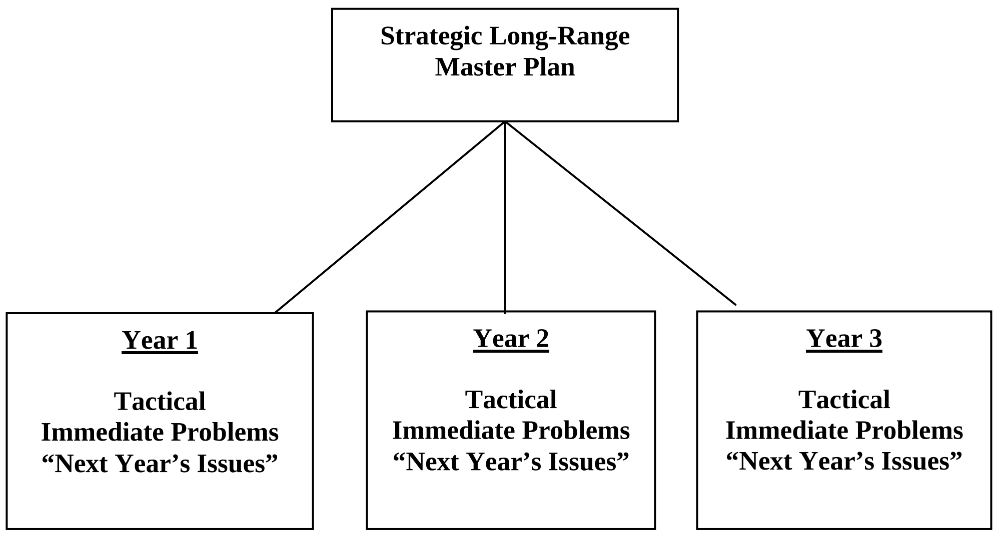
VII. PHASED IMPLEMENTATION SEQUENCE

The first step is for the administration and School Board to study the Report and Options, communicate with the community and, ultimately, for the School Board to adopt a Long-Range School Facilities Master Plan. Then, the Board will develop a step-phase sequence for implementing the plan over the subsequent four-six years, possibly using the following outline as a model or guide for whatever plan is ultimately adopted. Assume, for example, the adoption of Option/Phase X as the Master Plan by January/ February, 2009 and use the following pages as a model for implementation of the Plan. Using this model, a similar implementation schedule could be developed if Option/Phase I, II, or III were selected.

A word of caution is in order here. We all have a human tendency to focus on immediate issues and concerns. Failure to have a long-range strategic plan that encompasses the entire scope of the program over a decade or more often leads to decisions that may temporarily resolve an immediate problem while building in some significant longer term problems. Implementing a Long-Range School Facilities Master Plan in phases is desirable for several reasons:

a) funds can be expended over a period of time;
b) care can be taken to provide adequate supervision of the several projects; and
c) students can be subject to less disruption of their schooling.

The administration and School Board should think, plan, and act both strategically and tactically. Adopt a long-term Strategic Master Plan, and then make year-to-year tactical decisions that aim toward the eventual attainment of the Master Plan Goals. As year-to-year decisions are made, care should be taken to ascertain that they are in concert with the Strategic Long-Range Master Plan.



The problems are, unfortunately, somewhat expensive, encompassing two levels of the school system (Grades 6-8 and Grades 9-12). Issues will not go away or self-correct. Sites will not expand, buildings will not grow nor will they self-improve. Rather, as each year passes, the buildings will only become more obsolete unless decisive action is taken to modernize them and to add the necessary facilities to support the programs.

We trust that NESDEC's analysis of the problems and the options presented will assist the School Board, the School Administration, and the District communities in resolving these issues in order to provide sound educational facilities for all of the Timberlane RSD's pupils...for many years to come. We see this Report as a beginning point for study and discussion. Ultimately, the School Board should adopt a Master Plan for Timberlane's future educational facilities and provide the community leadership for implementing the plan.

The NESDEC
Timberlane RSD Team

THE VISITING COMMITTEE REPORT

of

Timberlane Regional Middle School
Plaistow, New Hampshire

November 16-19, 2008

<u>Chairperson</u>
David Flynn
Director
Commission on Public Elementary and Middle Schools
New England Association of Schools and Colleges
Bedford, MA

<u>Assistant Chairperson</u>
Robert White
Retired Superintendent of Schools
West Bridgewater Public Schools
West Bridgewater, MA

Commission on Public Elementary & Middle Schools

New England Association of Schools & Colleges, Inc.

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THE DISTRIBUTION, USE, AND SCOPE
OF THE VISITING COMMITTEE REPORT

The Commission on Public Elementary & Middle Schools of the New England Association of Schools and Colleges considers this Visiting Committee Report of Timberlane Regional Middle School to be an important document submitted to the school principal, the superintendent of schools, and to the Commission on Public Elementary & Middle Schools of the New England Association of Schools and Colleges, Inc. Distribution of this report within the school community is the responsibility of the school administration, and it must be made available to the public within sixty days of the receipt of the final document. When released, it should be done so in its entirety.

The prime concern of the Visiting Committee has been to assess the quality of educational programs at Timberlane Regional Middle School on the basis of the school's own self-study and in terms of the school's stated Mission and Expectations and the Association's Standards for Accreditation for public middle level schools. Neither the total report nor any of its subsections are to be considered an evaluation of any individual faculty member but rather a professional appraisal of the school as it appeared to the visiting team.

INTRODUCTION

The New England Association of Schools and Colleges is the oldest of the six regional accrediting agencies in the United States. Since its inception in 1885, the Association has sought "to advance the cause of education in the colleges and schools of New England" and has awarded accreditation to those educational institutions in the six-state New England region who seek voluntary affiliation, comply with stated Standards of Membership, receive a recommendation for accreditation by the Commission, and make a commitment to the three-phase process of self-study, on-site visitation and follow-up.

The governing body of the Association is its Board of Trustees which supervises the work of six Commissions:

Commission on Public Elementary & Middle Schools

Commission on Independent Schools

Commission on Institutions of Higher Education

Commission on Public Secondary Schools

Commission on Technical and Career Institutions

Commission on American and International Schools Abroad

The Commission on Public Elementary & Middle Schools functions within the framework of the Association and has seven Standards for Accreditation for middle level public schools. These Standards reflect seven basic areas, each of which should be viewed by the school and its community as a vital element of educational excellence. They are: Mission and Expectations, Curriculum, Instruction, Assessment, Leadership and Organization, School Resources for Learning and Community Resources for Learning.

Within the Commission on Public Elementary & Middle Schools is the Committee on Middle Level Schools which oversees the accreditation process for the middle level schools belonging to the Commission.

The self-study of Timberlane Regional Middle School extended over a period of eighteen months and was organized and directed by a steering committee of nine members. Co-chairing this steering committee were: Jackie Oros and Elaine Binette.

During the self-study phase, it was the responsibility of the steering committee to appoint sub-committees of faculty and parents to assess the school in relation to each of the Standards for Accreditation and to the school's Mission Statement. To this end sub-committees utilized the self-study instrument An Investment in Planning the Future, a document which guided them through the process of discussion, consensus building, and the final appraisal of how each Standard was met, not met, or exceeded. The outcome of each of the sub-committee's work was a report highlighting the strengths and needs in each of the seven Standard areas including many specific to each of the learning areas. Upon completion of each Standard report, it was presented to the full faculty for a majority vote. The completed self-study document was then mailed to each member of the visiting committee and became the team's basis for the on-site visitation.

After the lengthy period of introspection by the school, a visiting committee of 12 members was assigned to the school by the staff of the Commission on Public Elementary & Middle Schools. Team members were recommended to the Commission and chosen on the basis of their demonstrated abilities in their own school settings in New England. Members of this visiting committee came from the states of Connecticut, Maine, Massachusetts, and New Hampshire. (A list of team members may be found in the Appendix.) It is important that the reader of this report realize that the visiting committee's role was not to act as educational consultants for the school but rather as peer professionals with the following responsibilities.

- To validate and evaluate the school's perceptions of its strength and needs, based on the Standards for Accreditation

- To assess to what degree the school's programs are reflective of its Mission Statement

- To participate in "educational conversations" with peers in determining the unique characteristics of the school, where it needs and wants to go in the future, and the ways in which it believes it can get there

- To prepare written commendations and recommendations designed to strengthen/improve education.

In the weeks following the on-site visitation, this report was prepared by the chair of the visiting committee and submitted to the building principal for dissemination. It was also forwarded to the Commission on Public Elementary & Middle Schools of NEASC, a group of twenty New England educators (and one public member), elected to study the report and subsequently to make a decision regarding the accreditation status of the school. It is important to remember that the visiting committee does not make a decision regarding accredited status. On the following pages you will find a report on each of the seven Standards for Accreditation written by the visiting committee and reflective of the evidence gathered to make quality judgments and observations about the school. Each of the Standards' reports is divided into four sections: descriptions, perceptions, commendations and recommendations.

Please accept my thanks and the appreciation of the entire visiting team for your hospitality during our visit. We thoroughly enjoyed our housing and our meals. You certainly made us feel at home in your building, and, very quickly, we felt integrated into the daily routine of Timberlane Regional Middle School. From the very obvious building needs to the implementation of a new academic, social and organizational approach to working with middle level students, life at Timberlane is busy, sometimes frustrating, always energetic and rewarding. We hope that this report reflects what you see on a daily basis. You are in a school of which you can be proud, and you are in a school which continues to grow and change for the betterment of kids. You have done much work, and there will always be more to do. However, do not forget to stop and reflect on who you are and what you do and why you do it. I think, then, you will be pleased.

We came to serve you as ambassadors of NEASC and, by being in your building for three and one half days, the truth is that we have been served instead. Thank you.

SCHOOL AND COMMUNITY

Timberlane Regional Middle School is located in Plaistow, New Hampshire, and serves the communities of Atkinson, Danville, Plaistow and Sandown. Situated in southern New Hampshire just north of the Massachusetts border and the Merrimack River, Plaistow is approximately 25 miles inland from the Atlantic Ocean and almost equidistant from Portsmouth, NH (33.5 miles); Manchester, NH (36 miles); and Boston, MA (39 miles). The middle school is located in a residential wooded area, while the entire district ranges in character from rural to suburban. The nearest city with a population over fifty thousand is Haverhill, MA, adjacent to Plaistow, four miles from the school. With proximity to Route 495 in Massachusetts, district commuters have reasonable access to major highways (I-95 and I-93) and commercial centers in Massachusetts and New Hampshire.

In a fifteen-year period the population of the Timberlane Regional School District increased over 28% (from 19,098 in 1990, to 24,501 in 2005) with the greatest increases taking place in Danville and Sandown. 2005 census figures indicate 6,613 residents of Atkinson; 4,394 residents of Danville; 7,769 residents of Plaistow; and 5,725 residents of Sandown. The District's make-up is over 99% Caucasian with 0.5% Asian. The median income for households in the district is just over $65,000, with Atkinson at the high end ($69,729) and Danville at the low end ($57,287). The District is mainly residential; there are no major industries in any of the four towns. Atkinson and Plaistow have retail and sales centers, whereas Sandown and Danville only have small stores. Plaistow's largest employer is the school district with 455 employees, followed by Market Basket (225), Wal-Mart (222), and Shaw's Supermarket with (160). Atkinson's largest employer is Lewis Builders with 88 employees. Neither Sandown nor Danville has firms that employ more than forty people. As in other communities along the Massachusetts border in Southern New Hampshire, the District has seen a dramatic rise in the cost of housing over the past decade. The unemployment rate in the district ranges from a high of 4.5% in Plaistow to a low of 3.4% in Danville. The percentage of families living below the poverty line ranges from 2.1% in Plaistow to 3.3% in both Atkinson and Sandown.

In addition to the middle school, there are five elementary schools and one high school in the District, for a total student population of 4,463 in the 2006-2007 school year. There are no non-public schools in the District other than private kindergartens. The District offered public kindergarten for the first time in the 2007-08 school year. School choice is not an option in the State of New Hampshire.

Education is funded primarily through local and state property taxes. The percentage of local property taxes allocated to the District's schools was 57.9% for the 2005-06 school year. The following chart shows the per pupil expenditures for the middle school and the state average for other middle schools in the state of New Hampshire over the three year period from 2004 through 2007:

2004-05=	Timberlane	$8,727.82	State $8,559.98
2005-06=	Timberlane	$9,473.59	State $9,208.20
2006-07=	Timberlane	$10,224.39	State $9,821.37

Timberlane Regional Middle School receives no Title I funding.

The School and Students

Timberlane Regional Middle School enrolled 1,105 students as of September 4, 2008. The ethnic/racial/cultural composition of the school has remained consistently around 99% Caucasian since the middle school was built in 1974. Student population peaked in 2004-05 with 1,193 students and has declined each year to the current number 1,105. Student population projections indicate a leveling-off or slight decline in the near future.

Timberlane Regional Middle School employs 124 full-time highly qualified regular education and special education teachers in 2008-2009. Included in this number are six physical education and health teachers, five world language teachers, seven music teachers, three family and consumer science teachers, three technology education teachers, two nurses and three art teachers. This full complement of unified arts professionals is an indication of our commitment to educating the whole child. In addition, we have 54 para-educators, kitchen staff, custodial support and office personnel that provide additional support for our students and staff. Our staff is committed to supporting student learning. The average daily attendance (ADA) of our staff has been consistent over the past three years:

School Year	FTE	Member Days	Absences	ADA	ADA %
2007-08	103.00	19261.00	944.80	97.95	95.09%
2006-07	103.00	19261.00	763.30	98.92	96.04%
2005-06	100.00	18700.00	871.50	95.34	95.34%

Timberlane Regional Middle School takes pride in the fact that our students come to school ready to learn. The student daily attendance rate has been 95.4 percent for each of the previous three years. Students attend school 180 days per school year. The school day begins at 7:30 AM and dismissal is at 2:15 PM. There are presently eight early release days with dismissal at 12 noon. The students' annual instructional time, including unified arts classes, is 1036 hours.

Our mission statement guides our work with students. We are "committed to sustaining a collaborative learning environment so that our students may become successful, independent learners." The percentage of students with one or more failing grades has consistently declined over the last three years as teachers have worked to provide students with more formative feedback and support and the staff has embraced relationship-building through the Timberlane Regional Middle School advisory program as the foundation for our middle school learning environment.

School Year	Total Students	Students with 1 or more Failing Grades	Percent	Students Without Failing Grades	Percent
2007-08	1108	55	4.96%	1053	95.04%
2006-07	1123	98	8.73%	1025	91.27%
2005-06	1148	108	9.41%	1040	90.59%

Timberlane Regional Middle School is configured with four academic teams in each grade for a total of twelve school-wide teams. Each team consists of four core subject teachers, one each in mathematics, science, language arts, and social studies. In addition, teams have either a special education teacher or a Bridges teacher (at-risk student population), and paraprofessional support as needed. Students have seven instructional blocks per day lasting approximately 50 minutes. Teams have the freedom to use their core time for block scheduling. In addition to their core classes, students take unified arts instruction in the areas of technology education, art, family and consumer science (FACS), and world language in grades 6 and 7. Students attend physical education on an every other day schedule opposite the music/band program. Students in grade eight have a full year world language program. Timberlane Regional Middle School has a large special education student population that is supported on teams using an inclusion model. Our special education numbers have remained constant over the last three years. In 2005-2006 there were 224 students receiving services. In 2006-2007 we had 226 students receiving services and in 2007-2008, 229 received special needs services.

Timberlane Regional Middle School students take the New England Common Assessment Program (NECAP) which is used to assess school performance. All students in sixth, seventh, and eighth grade participate in the Fall NECAP in Reading and Math and eighth grade students participate in the Writing Assessment. The following chart reflects the teaching year.

Year	2005	2006	2007	2005	2006	2007	2005	2006	2007	2005	2006	2007
Proficiency Level	**4**	**4**	**4**	**3**	**3**	**3**	**2**	**2**	**2**	**1**	**1**	**1**
Grade 6 Reading												
Timberlane Regional Middle School	5	14	13	59	58	61	25	20	19	11	7	6
State	11	9	15	55	58	60	23	25	18	11	8	7
Grade 6 Math												
Timberlane Regional Middle School	11	10	15	43	48	47	26	20	23	21	22	14
State	15	17	19	44	45	44	20	18	21	21	20	16
Grade 7 Reading												
Timberlane Regional Middle School	13	7	16	58	66	56	22	22	22	7	6	6
State	11	10	13	51	56	54	26	24	23	12	10	10
Grade 7 Math												
Timberlane Regional Middle School	7	10	7	45	42	41	28	24	27	20	24	25
State	13	14	15	43	43	43	22	19	22	22	24	19
Grade 7 Writing												
Timberlane Regional Middle School	5	10	6	56	45	44	32	37	36	7	8	14
State	6	8	7	43	34	36	35	38	40	17	20	17

Although Timberlane Regional Middle School is a school in need of improvement in mathematics, it is clear from the data provided that we are improving and keeping pace with the state of NH each year. Our school improvement plan has been cited as exemplary and serves as a model for other districts.

Late buses are provided three days each week - Tuesday, Wednesday, and Thursday - for students involved in after school activities or tutoring. One bus is provided for students from each of the four towns. Timberlane Regional Middle School has an extensive interscholastic sports program for both boys and girls. After school activities are offered through our Enrichment Program and are geared towards student interests. This fall's offerings include board games, quilting, legos, book clubs, photoshop, math, dance, sculpture and computers.

The incidence of school discipline is another indicator of school performance. The numbers of in-school suspensions, out-of school suspensions, and referrals have decreased dramatically over the last three year. The decrease in year two coincides with the implementation of advisory at Timberlane Regional Middle School.

Year	In-School Suspension	Out of School Suspensions	Disciplinary Referrals
2005-2006	331	265	405
2006-2007	98	100	125
2007-2008	62	45	75

Timberlane Regional Middle School students are recognized by a wide range of academic and community awards such as honor roll, academic excellence awards for eighth graders, NELSM/NHAMLE Scholar Leader Award, music awards, spelling bee awards, geography bee, destination imagination, and math counts awards.

The core values of respect, responsibility and right choices are taken very seriously and are a foundation of our Timberlane Regional Middle School philosophy. Character development fosters responsible citizenship and provides an opportunity for students to demonstrate leadership. We honor and celebrate right choices both in academics and in personal decision making. Along with Student of the Month, our academic acknowledgment, we also have Character of the Month recognition. The Character Development Committee, comprised of guidance counselors and administrators, honors students who have been nominated by staff or by other students for making positive choices. On the last Friday of the month, nominees are sent an invitation to join the

Committee in the cafeteria annex. At that time, they have breakfast together and are given a bumper sticker and a certificate of recognition.

Students are given this recognition in connection with the core values of our school and with decision making skills. Often they have found money and returned it to the office or have found a wallet or an Ipod. Often we catch them doing something good like stopping in the hallway to help another student who has dropped his/her books or are having difficulty opening a locker. Students who volunteer to read the Words of Wisdom are also part of the Character breakfast. On average, there are between 25 – 30 students a month who are honored for their character. It is our belief that when we focus on the positive decision making skills of our students, they continue to make those right choices and become role models and leaders of our school.

Our parents are strong supporters of education and have passed budgets year after year to show their support. Parents participate in the school in a variety of ways, but especially through their membership in the Parent-Teacher-Student-Association. The Parent-Teacher-Student-Association is an organization that is critical to the overall success of Timberlane Regional Middle School. Our middle school has been the recipient of the Partners in Education Blue Ribbon Award for the past 18 years because of the phenomenal support we receive from our parents. This honor is given to schools with exemplary PTSA organizations whose members contribute extraordinarily high volunteer hours in any given year. In the 2007-2008 school year Timberlane Regional Middle School saw over 950 volunteers donate over 9,700 hours in the service of students and staff. Various celebrations, fundraisers and honorary events account for the hours served. An example of a wonderful activity that takes months of planning is the Senior Tea. For the last 29 consecutive years the PTSA has sponsored a community event called the Senior Tea. The grandparents and grandfriends of our students and members of the Senior Centers from our regional towns are all invited to a social. The event includes wonderful homemade finger foods, music provided by the student band and select chorus. Students work along with the PTSA decorating the cafeteria, waiting on tables and help with the clean up after the event. The Timberlane student musicians from band, orchestra and chorus put on a wonderful Christmas show. All the seniors leave with either a poinsettia, plate of goodies and all get a small present.

The PTSA plans a week long Staff Appreciation Week, celebrations for grade levels; they help organize fund raisers such as the Magazine Drive and the 8th grade Career Day. Timberlane Regional Middle School is grateful for the time and talent donated year after year by the parents of our students.

Timberlane Regional Middle School has strong ties with the community. Over the past twenty nine years, a partnership has been developed and refined with our local senior citizen center, the Vic Geary Center. The middle school sponsors a community service project with our student senate, where students go to the Vic Geary Center and serve icecream, fill eggs with candy for the town egg hunt, make valentines and get well cards with the seniors. We have also presented a medieval banquet complete with food, props music, jesters and maypoles with the dancers for the seniors' entertainment.

Another community partnership that the middle school had is with Anton's Cleaners. Each year the middle school sponsors a coat drive in which students and staff donate warm winter apparel for the needy. Anton's cleans and presses each garment before it is distributed to the disadvantaged.

Last year student advisories and staff donated money to "Pennies for Patients", cancer organizations, fire victims in our own community, aid for a local police officer and his family, animal shelters, fire victims in Lawrence , Santa's helper and many more. The seventh grade advisories are focused on community service and are always looking for ways to be involved in community projects.

MISSION AND EXPECTATIONS

OBSERVATIONS AND CONCLUSIONS

MISSION STATEMENT

The Timberlane Regional Middle School is committed to sustaining a collaborative learning environment so that our students may be come successful independent learners.

It is our mission to:

- *Provide a safe, respectful and nurturing environment that encourages enthusiasm for learning*
- *Foster responsible citizenship and provide opportunities for students to acquire and demonstrate leadership and service*
- *Provide a challenging, integrated, standards-based curriculum*
- *Meet the individual needs of students by identifying differences and using assessment to differentiate instruction and learning*

The Timberlane Regional Middle School Mission Statement was developed and articulated over a span of time of administrative change at the school. Three key factors contributed to the committee's initial work: the previous mission statement, which was reviewed and discussed; the core values of Respect, Responsibility, and Right Choices, already established in the life of the school and the Timberlane Regional School District's Mission Statement. The Mission Statement Committee, charged with formulating a new mission statement, facilitated the establishment of a workable document. This original document was thoroughly discussed and "tweaked" not only by the faculty and administration, but also by the students, parents and the central office and school board. In its final form, the Timberlane Regional Middle School Mission Statement was approved by the school's faculty on May 7, 2007.

The Timberlane Regional School District Mission Statement is *to educate all students by providing challenging opportunities that emphasize high standards and continuous improvement and to prepare them to be responsible, self-sufficient, and contributing local, national, and worldwide citizens.* The consonance between the two mission statements in the concern for character development and high standards for learning is a clear indicator of the purpose and goals for educating middle school students.

The statement expresses the common district-wide goal of educating students to "become successful, independent learners." During the time of developing the mission statement, the current principal began the process of moving the school to an authentic middle school model and had introduced an Advisory program that took root in the culture and climate of the school and provided a creative and authentic means for embodying this stated mission in the Timberlane Regional Middle School community.

During the NEASC visit to the school, a representative group of students told members of the Visiting Committee that the words of the Mission Statement were "pretty fancy" and were very representative of the ideals of the adults who teach them, but the students affirmed and identified the Core Values of Respect, Responsibility and Right Choices as their "handle" on the Mission Statement. Timberlane's core values of "Respect, Responsibility, and Right Choices" are not simply empty signs posted around the school. They are visibly operational in student behavior, varied approaches toward instruction and administrative leadership.

By embracing both a "safe, respectful, and nurturing environment" for students and a "challenging, integrated standards-based curriculum," Timberlane Regional Middle School seeks to provide a place where early adolescents can, indeed, become "successful, independent, and life-long learners" and implement the values identified throughout the school. The Visiting Committee witnessed this countless times in the classrooms - from Advisory Group meetings, to cooperative reading groups analyzing differing primary source viewpoints on American Slavery, to careful scientific lab work, to students interviewing each other in preparation for their parent conferences regarding their first term grades. Enthusiasm for learning is being encouraged by highly qualified teachers who are themselves committed to sustaining the unique character of a middle school learning community. Just as the Timberlane Tiger theme, so pervasive in the school, resonates in the orange and black tiger striped border of the Mission Statements posted throughout the classrooms, so do the curriculum and instructional practices presented in those same classrooms reflect the educational values of the statement itself.

The Timberlane Regional Middle School Mission Statement and Core Values are printed in the student agenda book followed by a full listing of academic, social and behavioral expectations for students. Each school year begins with a full discussion of these expectations within each grade-level team, and students and their parents are expected to acknowledge and understand them by signing the documents. With the visibility of the Core Values posted throughout the school, daily "Words of Wisdom" provided everyday and the reinforcement of these values received through the Advisory Program, both teachers and students have observed and appreciated improved hallway behavior along with a generally more respectful climate throughout the school. Disciplinary actions have declined as noted in the dramatic drop in suspensions, both in school and out of school and a corresponding decline in disciplinary referrals. The Core Values are also used as a tool to help students reflect upon their own behavior when that behavior has brought them into a situation needing corrective action. Quarterly academic grading assessments also include the consideration of effort and conduct, and the work of the Character Development Committee rewards good behavior through monthly "Good Character" awards that are given alongside “Student of the Month” awards. The validity of the Timberlane Regional Middle School Mission Statement is demonstrated daily through the positive climate that students and staff sustain and the academic success students are encouraged to reach by the adults devoted to their educational needs. While the visiting committee saw many examples of the mission statement and core values in action, it would be helpful to the school to establish a rubric by which it could measure its success in meeting these expectations.

The Visiting Committee had several opportunities to meet with parents, students, central office personnel, and school board members, both informally, throughout the school, during the welcoming reception, in the lunchroom and corridors and formally, during the scheduled meetings with cross-sections of these various constituencies. Parents expressed themselves as pleased with the more open and receptive direction the school has been given under its relatively new administration. Students are happy to be in school and proud of their school community. As guests in this building, the Visiting Committee members experienced a connection between the mission statement and stated expectations of student behavior and the enthusiastic climate of learning and good citizenship observed throughout the building. The creative wall paintings and numerous displays of student work suggest a place “owned” by the students who have done or who support the creating. The on-going financial support provided by the towns of Atkinson, Danville, Plaistow, and Sandown is a real indication of the communities’ support of the Timberlane Regional Middle School mission and pride in the school’s achievements.

The Mission Statement ensures that students and their needs are in the spotlight at Timberlane Regional Middle School. At the beginning of the school year, the mission and expectations are reviewed with the student body in their grade level orientations ensuring that all new students are also acquainted in some way with the mission statement and expectation. As faculty discuss issues of school climate, student behavior and academic “rigor,” these documents provide a touchstone from which to make judgments and decisions. When students are disciplined, these documents provide the written code that forms the basis for any final outcome in any administrative action. And it is the Mission Statement that provides the foundation for innovative student-centered programs, such as the recently established Advisory Program.

There is no formal methodology for reviewing the mission statement periodically at this time. If, however, the mission and expectations documents are to be current and applicable, some form of review by the full educational community becomes an opportunity to renew the educational covenant it expresses between faculty and students. How well the mission statement is woven into the fabric of the life of Timberlane Regional Middle School depends upon how well all members of the educational community are aware and invested in it. .

COMMENDATIONS

The visiting committee commends Timberlane Regional Middle School for:

1. The development of a mission statement which is in concert with the district statement and connected to the core values of the school
2. The active use of the mission statement as a guide to planning and decision-making
3. The mutually active awareness of the mission statement and core values by the students and faculty
4. The visible postings of the mission statement and the core values

RECOMMENDATIONS

The visiting committee recommends the following:

1. Establish a Mission Statement review process which includes membership from all TMRS constituencies
2. Develop and use a school-wide rubric for assessing continuously the school's success of the mission statement and expectations

CURRICULUM

OBSERVATIONS AND CONCLUSIONS

Timberlane Regional Middle School's written curriculum provides for the design and implementation of meaningful curriculum. The curriculum is related to the school's mission statement and the New Hampshire Frameworks for curriculum. The curriculum also links expectations for student learning and social behavior to instructional and assessment practices.
The school's curriculum is aligned with the New Hampshire frameworks for curriculum and the expectations for academic achievement are in some phase of the process of being outlined in all of the core curriculum areas. The social studies district committee has unpacked the New Hampshire Frameworks standards and is engaged in unit design using the essential questions and enduring understandings. Lesson targets posted in most class rooms help focus students on the curriculum.

Timberlane Middle School has social expectations which are manifested by student behavior and supported by the implementation of school wide advisory groups. Many of these groups address the social, emotional, and or educational needs particular to middle school aged children. The goals of the advisory program call for the development of a climate in which the social expectations can flourish. The school hallways and classrooms are festooned with the core values of *Respect, Responsibility and Right Choices* to remind students of the schools expectations for social behavior.

Many of the curriculum documents have been rewritten in the Understanding by Design format, which clearly references the New Hampshire grade level expectations, recently changed to GSE, (*Grade Span Expectations*). The grade span expectations are then connected to the Understandings, Essential Questions, Knowledge, and Skills which students will be able to achieve as a result of the lessons in the unit. Curriculum notebooks contain the learning standards for each content area; some of which are in the possession of each teacher, while others are located in central departmental areas. The teacher-based curriculum notebooks were full of units developed by teachers to follow the basic curriculum formulated by the district committees. The visiting committee observed the standards posted in several classrooms.

Students are made aware of the academic expectations at the beginning of each year when they receive their student agenda books which contain not only the academic expectations but also the social and performance expectations as well.

At the time of the visit, there was a perceived concern about the rigor of the curriculum. Some of this is caused by the change from homogenous to heterogeneous groupings within the classrooms and the resulting need to differentiate instruction. The school is cognizant of the need to strengthen the design to ensure that all students are challenged to their potential and their learning personalized, reflecting a true heterogeneous model. Teachers have to learn to use the heterogeneous model as a strategy to challenge the individual and not the group. The learning plan template is designed to assist teachers in planning and differentiating lessons. The curriculum, as currently designed, offers teachers the opportunity to meet the individual needs of all students to balance community and content, but there needs to be more hands on understanding by the staff to make it work.

The curriculum is respectful of the differences among the students and, as presented, invites students to be risk-takers as well as to demonstrate their knowledge through the use of projects and performance.

Timberlane Regional Middle School's course work meets the needs of middle school learners through the implementation of unified arts classes which include art, physical education, technology education, family and consumer science, music, Spanish, and French, all of which offer opportunities for students to explore different avenues and, at the same time, apply the skills learned in the core curriculum to other areas. Other educational experiences such as the Bridges program are in place to meet the needs of students who may be academically, socially, or behavior challenged at the middle school. The program requires parental permission and support. Students may receive in and out of class support and after-school homework help. There is on going supervision and monitoring of both behavioral and academic performance to help students achieve their best academically and socially.

Co-curricular after school activities three days a week offer students a chance to be with others sharing the same interests in a variety of activities. As with the advisory groups that meet every morning, the after school activities address the diverse social and academic needs of middle school children, running the gamut from highly social activities such as the school drama club getting ready for a performance of "Annie", to the 'Lego" club where the students choose to create alone or with others and to share their creations with the group or not.

The Timberlane Regional Middle School has two curriculum coordinators, one of whom coordinates social studies, language arts, and world language, and the other, science, math, and technology. Their primary role is to assist teachers in establishing and implementing developmentally appropriate and intellectually challenging content. The coordinators play an active role in coaching teachers through the issues of rigor and differentiation. Meeting times are set to enable a focus on content, integration and delivery.

There are district K-12 curriculum committees whose function is to ensure that curriculum is articulated from kindergarten through high school. Direct coordination among the five elementary schools and the middle school is inconsistent, and, although there is K-12 synchronization through the committees, it does not resolve the variation. During the visit staff pointed to inconsistencies concerning coordination between receiving and sending schools in the district.

Coordination with the high school demonstrates some of the same issues. The visiting committee was informed, for instance, that the software used by students at the middle school is several years behind what they will encounter at the high school. At the same time, some 8th grade staff report yearly contact with high school staff concerning the incoming freshmen. The unified arts staff, world languages and music, reported that they are in contact with the high school staff in their particular areas often.

The district utilizes a mentoring program which provides a training schedule for new teachers to communicate the curriculum practices of the district. Third year teachers receive focus training in integrating differentiated instruction and Understanding by Design.

There are varying degrees of integration across the curriculum, although it was clear that the faculty supported the concept wholeheartedly. During the last two years, there has been a well defined initiative to integrate literacy with all other curricula. It is imbedded into the work of each core class, and reflects a recently written school philosophy stating, “Today’s students need sophisticated literacy skills in order to negotiate a rapidly changing world.” Every teacher is required to use literacy as a fundamental component of understanding and assessment in their content delivery. The library provides resources and materials that are inclusive of more than one curriculum to support integration as well as supporting research which sustains ongoing classroom projects. The visiting committee saw examples of student work that resulted from a combination of language arts and social studies.

The district has a continuous process of evaluation, revision and implementation. The phases of the process include one year to write, one to assess, and one year to pilot or adopt the proposed curriculum. This is followed by a five year period of implementation and evaluation, after which this cycle begins again.

The process is set to a staggered schedule for different curriculum areas. For example, the social studies district committee is in year two of the rewrite process, while science and math are finishing year three of the revision cycle. In year three, the curriculum is aligned to the latest state standards and grade span expectations are decided upon. The language arts curriculum is in the implementation and evaluation portion of this cycle which takes place over a five year period. They have created essential questions and understandings for all three grade levels in language arts using the Understanding by Design Unit Template.

There was little mention during the visit of using data gained from standardized testing to influence curriculum change directly. In one discussion with teachers, it was noted that, since the curriculum is carefully aligned by the district with the learning goals of the state of New Hampshire, the data will have little effect on curriculum change. At the same time, the curriculum coordinators implied that data are certainly factors in curriculum change, because they inform the district about trending and emphasis. Of vital importance is national and state research into what knowledge and skills will impact the students' education beyond middle school.

The ongoing process for curriculum review at Timberlane Middle School is to be commended. It is well thought out, inclusive of faculty input K-12 and thorough in its attempts to be timely, comprehensive and student centered. Two points of view about curriculum review and implementation were expressed, the first being that there is not enough time to develop, review and revise content at the building level, and the second being that there is ample meeting time built into the schedule to do so effectively. The professional staff should arrive at a consensus on this matter.

Part of the curriculum development and review process includes providing resources to support the implementation. Among those resources is the library. The Timberlane Regional Middle School library is a large area with ample room for materials, resources, equipment and work space. Its holdings are fairly extensive and support the written curriculum. Curriculum groups work closely with the librarian to research, review and select appropriate materials to support instruction. These resources range from magazines, newspapers, videos, to on-line resources. Various online resources are available to staff and students from computers at school and at home. Some examples are, *World Book on line*, *Facts.com*, and Grolier *Deluxe online*. The library carries a variety of video and digital supplements, as well as books on tape, which are available to staff for accommodating different learning styles. Materials are modified to respond to the changes in curriculum and the librarians take an active role in the curriculum process by identifying trends which signify interest levels and help to manage appropriate purchasing. With the institution of the Advisory groups, the need for more and varied research materials has been an issue as some groups begin more independent research projects, and the library has made accommodations to provide them.

The various curricula identify the utilization of technology as an integral part of the learning process. The school provides a variety of technological tools and opportunities to support teaching and learning. In addition to four computer labs, students have videoconferencing, hardware and software, web-based libraries and individual login accounts. The written curriculum incorporates classroom and school-wide technological resources. Science teachers are incorporating the use of microscopes for individual students and a microscope used with a monitor for displaying samples. There are on-line resources available to students and staff including, but not limited to, membership in United Streaming which the visiting team observed being accessed in an Art class, and the interactive 'Brain Pop' site. Staff may sign up for a computer lab to utilize the equipment or sign up for the mobile computer cart to use in their classrooms. The labs are used for literacy group enrichment. An example of this was a group exploring forensics on nobelprize.com. The past year has seen a change in the roles of two of the technology education teachers from that of a team approach, fostering collaboration and integration of content area curriculum, to a more formal approach to keyboarding and word processing techniques. The use of technology brings with it a set of maintenance issues, which were pointed out to the visiting committee during the visit a number of times as a limitation on good teaching and learning.

Professional development opportunities are offered throughout the year according to the curriculum folder calendar. There are monthly mandatory professional learning committee meetings. Teachers are offered eight early release days a year with two Professional development days in September, one in January and one in August. These meeting are usually planned by administration. According to a staff survey most are satisfied with the resources and supplies offered throughout the district, (162 respondents). The visiting committee noted that staff requests for materials to support the written curriculum were almost always honored. Even though most staff felt they had sufficient professional development time, the time for peer collaboration was insufficient. Common planning time seemed to be used for other types of meetings.

COMMENDATIONS

The visiting committee commends Timberlane Regional Middle School for:

1. The alignment of the curriculum with the New Hampshire frameworks
2. The development of a clearly defined curriculum development, review and revision process
3. The creation of a curriculum that has as its primary focus the middle school student
4. The alignment of the curriculum with the school's mission statement
5. The commitment to professional development by the district and the school
6. The integration of literacy across the curriculum
7. The formation of interdisciplinary units across the curriculum
8. The accommodations made by the library to be a continuous support for curriculum
9. The district commitment to K-12 curricular articulation

RECOMMENDATIONS

The visiting committee recommends the following:

1. Develop and implement a plan to ensure all teachers are aware of and using the Understanding by Design process
2. Develop and implement a plan to provide continued professional development in the understanding and implementation of differentiated curricula
3. Develop a professional development module to focus on instructional technology to support the integrated curriculum
4. Develop and implement a process to establish a consensus around the definition and application of content rigor in a middle school
5. Review the curriculum review process to ensure inclusion of all classroom teachers during the process

INSTRUCTION

OBSERVATIONS AND CONCLUSIONS

Timberlane Regional Middle School is a building bustling with productive energy which is marked by the teaching and learning process. Over the past few years, both the district and the school have participated in a wide range of workshops and professional development opportunities to introduce and implement instructional practices that meet the needs of all students in the school. As the middle school philosophy has been integrated into the routines of the school, so, too, have the instructional approaches changed to ensure that every student has an opportunity to learn. Included among the various models is the research of Marzano, Bloom's Taxonomy, Understanding by Design, Jensen's brain based learning strategies, Gardner's multiple intelligences and a variety of experts in differentiated instruction. The investigation and commitment to these models enables the school to live out its mission by providing different approaches to teaching students with a multiplicity of diverse needs and styles.

The visiting committee found Timberlane Regional Middle School to be a place that is student centered and reflective of many middle school practices. The adults were very caring and genuinely interested in the well being of the students as well as their academic success. Parents reported that they believe that the staff know their children well and care deeply about them as individuals. The implementation of the middle school philosophy and, concurrently, the initiation of heterogeneous grouping was a catalyst for the school to alter its instructional approach to enable all students to meet the school's high expectations. During the visit, the committee witnessed examples of flexible grouping, cooperative learning, jigsaw activity, pair/share and four corners activities as a means of meeting the diverse needs of the students. Many of the staff were cognizant of differentiated teaching and learning strategies and were incorporating them into their daily classroom routine. At the same time, there were also examples of teacher directed lecture and the use of busy work, which are expected during a period of transition, but which need to be addressed continually.

The staff, through a series of discussions and brainstorming, identified a list of best practices that can be used in a middle school environment. Some of the practices observed during the visit were the use of the Key 3 note taking program, choices regarding test levels, and various graphic organizers. In addition, there was an indication that some teachers are beginning to work with the research of Robert Marzano and integrate it into their own work. . The visiting committee viewed this approach as a solid first step towards providing best practices and learning opportunities for all students.

The curriculum coordinators work with teachers individually and in groups to enhance their instructional strategies. They plan and implement workshops, courses and one on one conversations, as well as provide resources for teachers to use in preparing their lessons and units. The visiting committee noted that there were many initiatives in process at the school, many of which were managed by the curriculum coordinators quite effectively. There is a transparent understanding that the implementation of the middle school philosophy and its accompanying instructional changes is a process and not an end and requires the development of capacity. Staff members approach each change at their own pace, and the coordinators work closely with each of them ensure that the staff is moving toward the same goal. During the interviews with teachers, a concern was raised about the level of rigor found in the instructional planning. Teachers also reported that due to a focus on remediation, the academic needs of high achieving students may be overlooked. When this was broached with the curriculum coordinators, they indicated how aware of the problem they were and indicated that increasing and/or maintaining rigor and balancing it with a middle school approach to learning was an active objective of their work

Throughout the visit to Timberlane Regional Middle School, the visiting committee observed many examples of quality instruction taking place. Some examples include open ended writing activities, projects, self directed library visits, and games to reinforce learning. At some grade levels, thematic units of instruction have been developed by teams of teachers. These units of instruction are viewed by staff as explorative, challenging and fun for the students. These hands on learning experiences provide opportunities for flexible grouping, differentiated instruction, and other best practices in instruction. For example, in grade seven the students were researching and preparing plays to examine the history of Greece. A second example of a hands on activity was the reenactment of the Civil War in a grade eight social studies class.

The school is utilizing a tiered instruction model for language to ensure it is meeting the needs of all students. For example, in the area of language arts, all students receive Tiered One instruction, a percentage of students will receive a Tiered II language program (Read 180) and other students will receive Tiered III instruction (Language!) All other students participate in a literacy block.

In 2008, a new literacy initiative was established. All teachers implement the literacy initiative across content areas for the purpose of tiered instruction. Some teachers and parents reported concerns about how reading was currently being taught at the school. Previously, students had reading as a part of their daily instructional program. Currently, reading is incorporated into the content curriculum in all grades. Both teachers and parents expressed concerns regarding this approach. Although some training in reading across the curriculum has been offered to staff, some teachers expressed concern that they did not feel that they all had the skills/training to use a content based reading approach adequately. A second concern expressed by teachers is the amount of content time used in this reading approach. Parents, during the parent interview expressed concern that "the classics" are no longer being taught to their students.

At some grade levels Unified Arts teachers work closely with the team teachers. The Unified Arts teachers report that this allows them to plan innovative units of instruction that connect directly with the content being taught at that grade level. However, the collaboration between teams and Unified Arts is not a consistent practice throughout the school due to scheduling conflicts.

Several curriculum areas are being reviewed to support instruction in support of higher order thinking skills. It appears that there has been some training about using Bloom's taxonomy to support high level thinking skills but it is not prevalent at this time. Teachers also reported that they are encouraged to be creative in their lesson planning and are encouraged to use Understanding By Design template to create well thought out lesson plans. During the visit several higher level thinking activities were viewed by the visiting committee, including using primary sources to read and analyze a slavery document, journals and questioning. In math, there was a lesson which focused on creating examples and non examples of fractions, and lab work in science classes was observed. In an Advisory meeting, there were teachers and students discussing goal setting techniques. This is an area that will need more focus and training.

Teachers reported that teams need time to develop and implement interdisciplinary units of instruction. Grade level academic groups need time to reflect and to discuss instructional strategies, create formative assessments and look at data regarding student achievement. Building level departments need time to work together to coordinate vertical curriculum between grades 6-8.

Technology is becoming an integral part of instruction. Although technology training has been provided by the district, not all teachers have adopted it as a regular instructional strategy. The school is also restricted because of the large number of students and the limited space for computer labs. Finally, although there is a wide variety of equipment available, it is insufficient for a school of that size. For example, there are two Smart Boards available in classrooms. In addition, there is one computer lab to students and one Computer on Wheels available for students. The visiting committee observed the mobile computer being utilized by students. Other technology used to improve student learning included students looking at microscopes attached to a television monitor, students typing written assignments on computers, a Current Event Podcast for students as well as a terrific video prepared for the committee on its arrival. Nonetheless, the limited access impedes the learning opportunities for some students, and there is a need to develop a plan to improve the current status of technology. Although the school's self study did not articulate a significant need for additional technology, the visiting committee viewed the inconsistency of available technology as an area of need. For example, art teachers reported that Adobe Photoshop would enhance the quality of instruction. The pace of story writing was based upon the number of computers available within each classroom. In addition, parents reported that they feel there could be improved communication through the use of the Power School grade book component being viewable by parents.

A wide variety of professional development opportunities are available to staff based upon school initiatives and areas of interest. Several teachers reported that the building administration will go to great extremes to secure resources to help the staff obtain professional goals. All staff interviewed reported that they feel that they have the resources needed to do their job well. The visiting committee observed ample resources, outside of the area of technology. Examples include consumables, a professional library and microscopes.

One consistent area of concern raised by the staff is the lack of time for reflecting, planning, and working in Professional Learning Communities. Teachers believe that instructional practices would improve if there was more professional development time devoted to the sharing of successes, ideas and instructional strategies across grade levels. In those same conversations, there was some rebuttal, as staff pointed out the many opportunities for groups to meet as content areas, specific committees, and grade level meetings.

There have been many school initiatives in the past few years. Each of them is related to improving instruction as it correlates to improved student learning. Some of these initiatives include: Advisory, Brain based theories, Marzano's theories, Rick DuFour's Professional Learning Community, Understanding by Design, and others. The administration and the curriculum coordinators acknowledge that the many initiatives have hampered progress to a point and have made the decision to prioritize them with the ultimate goal of reducing them. There is a concern that these many initiatives related to improved student learning lack a single vision and purpose and a lack of connection among them. For example, some teachers are using the Understanding by Design template to plan instruction; others do not. Some teachers embrace the work of Marzano, while other teachers are not familiar with his approach. The self study referenced the use of Differentiated Instruction several times. While some evidence of differentiated instruction was observed by the visiting committee in the form of test options, rubrics and completion choices, it was not as observable as one would have expected. It was obvious that some teachers have mastered the use of Differentiated Instruction, while others are struggling to build capacity. The visiting committee recognizes that this is an integral component of change but believes that it is a priority for the school in determining internal goals.

The improvement of instruction is a constant topic of discussion within the culture of the school. Much of the work of the curriculum coordinators is to engage teachers and groups of teachers in that discussion with the sole purpose of learning as a community and sharing successes and needs. The school administrators use the Charlotte Danielson model for their teacher evaluation, but, in the interest of improved instruction, the administrative team, with the help of PDA's, is informally gathering data on the use of Marzano's best practices as a supervisory strategy. As this process was begun, the administrative team offered little or no feedback to the teachers. However, the plan is to begin to respond constructively.

COMMENDATIONS

The visiting committee commends Timberlane Regional Middle School for the following:

1. The implementation of a student centered, middle school philosophy
2. The use of research based programs to guide instruction
3. The implementation of an effective heterogeneous grouping process
4. The instructional leadership of the curriculum coordinators
5. The availability of a professional development library
6. The use of professional development opportunities to foster instructional change

RECOMMENDATIONS:

The visiting committee recommends the following:

1. Develop and implement a long range plan for technology at the school level
2. Establish a master plan for meeting time usage that identifies the purview of each group and meets the needs of the whole school in a connected, collaborative way
3. Prioritize and reduce the number of initiatives and develop an action plan to meet their goals
4. Provide opportunities for staff to follow up professional development presentations with implementation assessments
5. Revise curriculum to include opportunities to address higher order skills
6. Increase rigor in both curriculum and instructional strategies
7. Provide feedback from the Marzano supervisory process

ASSESSMENT

OBSERVATIONS AND CONCLUSIONS

Timberlane Regional Middle School states in its mission that the school is committed “to identify differences to meet the individual needs of students by using assessment to differentiate instruction and learning.” The school is clearly committed to the goals and purposes of a comprehensive assessment system to ensure the success of its mission. A variety of assessments - state, national and local – are incorporated into the day to day routine of teaching and learning.

The New England Common Assessment Program (NECAP is administered in the fall of each year at which time all students are assessed in Reading and Math and have been over the past four years. Eighth grade students have additionally been assessed in writing and science more recently. The staff reviews and analyzes them together, and they become a base for altering instruction and initiating professional development subject matter.

Students participate in the National Assessment of Educational Progress every two years, but since no results are returned, it has little effect locally. Assessments which are more commercially based include the 3 Tier Assessments, Physical Best Fitness Testing, Examview Pro, and writing prompts drawn from 6 Traits in language arts, math, science, and social studies. Some content areas use assessments specific to a topic or unit which may be drawn from outside materials.

In addition teachers construct assessments that pertain directly to their subject and grade levels and which are modified to meet the individual needs of the students. These assessments are shared across grade levels and through content area connections. Teacher made assessments include tests, quizzes, writing samples, open ended questions, portfolios, performances, conferencing, reports, simulations, debates Some have been formalized, while others vary based on the need and ability of the student and the class as a whole.

The Special Education department also uses a wide variety of assessments tools to gauge and monitor identified student levels. Scholastic Read 180 Program and Language! Are but two used to identify standing and modify instruction.

Interviews with teachers and classroom observations enabled the Visiting Committee to gather first hand evidence of classroom assessment strategies. Within classrooms, there were examples of questioning techniques, open ended questions and responses, rubrics posted in the rooms, brainstorming, small group collaborative work, discussions, whole group instruction and role playing performances. Students were observed in a class working together to formulate Newton's three laws in their own words. Other observations were made of math probes being used to assess understanding. A social studies class was working on a research project in the library and small groups were working together.

When the NECAP assessment results are returned to Timberlane Regional Middle School, they are reviewed and analyzed by a variety of staff at both the school and district levels. Curriculum coordinators, grade level teachers and content area teachers have been involved in different reviews and analyses at different times. The disaggregating of the data is not the sole work of one individual or one group, but, rather, is spread across the faculty and administration. However, the process is used productively to improve curriculum and instruction. The analysis of the NECAP data has stimulated the re-sequencing of geometry in the instructional order of the mathematics curriculum. Evidence has also shown that the NECAP data have been used to assist in the placement of 8th grade students in Algebra. The 6 Traits Writing and MathScapes programs were adopted as instructional tools as a result of needs and deficiencies ascertained from the data.

Teachers also use in class assessments to make determinations about teaching and learning strategies. Other examples of assessments which have been used to evaluate instructional strategies and which were seen by the Visiting Committee are Exit Tickets to gauge student mastery and understanding of new skills, and mathematics assessment probes. Degrees of Reading Power (DRP) and The Test of Silent Word Reading Fluency (TOSWRF) are assessment tools used for students with language based learning disabilities to gain access to the Language! program.

Students also have the opportunity to make judgments about their learning. The visiting committee observed different types of student self-assessment during the visit. Evidence of target lessons and goal setting was found in both classrooms and during the advisory period. At the time of the visit, students were preparing for student-led parental conferences in some 6th and 8th grade classes. This was a new phenomenon for Timberlane Regional Middle School and will need to be evaluated subsequently. Classroom observations enabled the visiting committee to see collaborative assessment through peer editing, small group projects and conferencing. Authentic student assessments were also seen in a variety of classrooms which included minimally science, math, art, consumer education, and physical education. There is also evidence that shows goal setting in the 6 Traits writing curriculum to assist students in gauging their own growth over the year and their time at the middle school... Interviews and discussion with teachers resulted in a strong interest among them to benefit from faculty discussion groups around the different assessment practices in order for all teachers to expand their own repertoire of classroom assessments.

Timberlane Regional Middle School has many different methods used to communicate with parents about student assessment. Report cards are distributed quarterly along with mid-quarter progress report in between. Communication with parents has a very high priority at Timberlane Regional Middle School, so, in addition to the eight formal reports to parents, teachers can inform parents of achievement concern or praise by phone and email, and, although the visiting committee did not actually see them, they were made aware of parents requesting reports on a weekly or bi-weekly basis, home school journals and parent/teacher conferences.

Parents can also access three websites to maintain an awareness and understanding of student successes and needs. On these websites, homework assignments are provided, curriculum and theme information is available. When parents were interviewed, they were very complimentary about the speed with which their inquiries were addressed by the staff. Not all of them had accessed the websites, but some had and found them helpful. They were aware that PowerBook, a grading program, has been piloted and will be a benefit to them. Parents also indicated that there was every opportunity to become aware of their student's standing, although many parents still waited for the school to inform them before seeking out further information. It was clear that this was a small, but obvious, issue to be worked on – encouraging parents to be comfortable in seeking information rather than waiting for it.

NECAP results are sent to individual parents on a yearly basis along with information on how to interpret the data. Parents indicated that this was an area which needed to be shored up. Most parents want to be led through the interpretation.

As a result of interviews with the staff and administrators, the visiting committee found that currently there are few common assessment standards. The school is in the midst of developing these for each standard area using the Understanding by Design model. Where available in draft and/or final form, they are provided to teachers with the expectation that they will be used for judging the progress or non-progress of the student. Ultimately, they will be incorporated into report card grading. Realizing that standards are the basis for measuring student growth, many teachers indicated that they send expectations home with the students at the beginning of the year, so that both parents and students will have the opportunity to understand them.

Evidence from a survey to staff shows that 60% felt that the district offers ample staff development opportunities in the area of assessment while 40% thought there that this is need for more. The survey also indicated that 66% of the staff surveyed desired additional time to create or develop new assessment strategies while 33% believe they have sufficient time. The staff has had professional development opportunities, including literature on the subject of Student Involved Assessment, and professional speakers to reinforce the understanding and methods to be used in their classrooms. The district employs two curriculum coordinators at Timberlane Regional Middle School to work with grade level staff on assessment needs.

As part of its strong commitment to good communication, the school and the district report assessment scores of the NECAP to the public in a variety of different ways. Some devices used are the District Annual Report, a release to local news papers, The School News Letter, Principal's Newsletter, Board meetings and discussion groups at PTSA meetings.

COMMENDATIONS

The visiting committee commends Timberlane Regional Middle School for:

1. The use of a variety of assessment strategies, both formative and summative, to meet the needs of all students
2. The commitment to and emphasis on assessment as a means of ensuring student success
3. The implementation of student-led conferencing
4. The use of assessment data to implement curricular and instructional change
5. The clearly posted goals, targets and rubrics to support good assessment technique
6. The processes used to inform both parents and community about the results of test scores

RECOMMENDATIONS

The visiting committee recommends the following:

1. Devise and implement a plan to review and appraise current assessment procedures
2. Develop and implement a process which will enable staff to continue to develop, create and share assessment strategies
3. Create a process for educating parents about each of the opportunities to receive assessment information pertaining to standardized test scores, website access and PowerBook
4. Evaluate the results of the student-led conferencing process and develop a plan to implement them
5. Establish a plan to align the report card with learning standards in each content area.

LEADERSHIP AND ORGANIZATION

OBSERVATIONS AND CONCLUSIONS

The principal of Timberlane Regional Middle School promotes and facilitates a vision that encourages the three core values of respect, responsibility, and right choices. Timberlane Regional Middle School uses collaborative interdisciplinary teams to support heterogeneous classes, centered on the middle level philosophy of instruction that supports the social, organizational, and academic domains for each student. All students and staff members begin their day by participating in the morning advisory program which serves to maintain the academic and social expectations for the students. In addition to core classes, students take unified art and physical education classes, world languages, and music and literacy classes. Students have opportunities to participate in the School Senate and the 8th grade leadership advisory. The leadership of Timberlane Regional Middle School has created a positive school climate of mutual respect and citizenship. The principal of Timberlane Regional Middle School is receptive to staff suggestions and concerns. The Building Council extends the opportunity for a representative from each team to demonstrate leadership by expressing ideas and concerns in a monthly forum. The school leadership recognizes the efforts and successes of students and staff, and advocates self-growth and leadership opportunities. The Timberlane Regional Middle School environment lends itself to constructive risk-taking that compels the students and staff members to reach their full potential. The parents of the school community commend the principal's strength as a school leader and the dedication of the staff to help students "become who they are."

The principal of Timberlane Regional Middle School is committed to providing leadership that communicates a vision focused on academic achievement and the social growth of the middle level child. The Administration has created a nurturing environment focusing on the three Rs. Students learn appropriate socialization during advisory and recess that is transferred to the classroom. The Principal demonstrates his devotion to the school community by sustaining and participating in the morning advisory program. The school's academic expectations are upheld though the differentiated instruction, literacy blocks and enrichment. The Principal supports staff professional development, trainings, teacher initiatives, and in-house talent as resources for school improvement.

The professional and support staff share the responsibility for maintaining the school's mission, high standards of achievement, and the social well-being of each student. Staff members accept their roles and responsibility in carrying out the school mission and doing what is best for their students. The staff assists in upholding the appropriate rules and consequences for student behavior aligned with Timberlane Regional Middle School's core values. The school structure of interdisciplinary teams and grade level meetings by content area enable teachers to take ownership in their work and evolve as leaders in the building. For example, some of the interdisciplinary teams are organizing student led parent conferences, and the physical education staff has developed a physical education advisory. In addition, some teachers take advantage of students grouping practices and Understanding by Design curriculum to meet the needs of all learners in their classrooms. The teachers at Timberlane Regional Middle School provide many opportunities for students to improve their work or obtain extra help if needed. School staff members rotate each year as members of the Building Council where they are encouraged to offer agenda items in order to address all building issues and concerns. Teachers expressed a strong comfort level in going to one another for collaboration and support.

The teachers and staff at Timberlane Regional Middle School are invited to assume leadership roles in the building. The faculty members participate in the hiring of staff members by reviewing resumes and interviewing. The new teacher mentor program enables veteran staff members to serve as mentors for new teachers or teachers new to the district. Interested teachers participate in curriculum development and professional development opportunities. For example, one teacher stated that she designed and offered a professional development workshop on reading strategies to the building paraprofessionals as a result of attending a reading strategy course. The Building Council extends an opportunity for staff members to bring forth and discuss issues as representatives of their teams. Empowering the staff at Timberlane Regional Middle School has compelled them to recognize one another with trophies at monthly faculty meetings.

The teachers at Timberlane Regional Middle School demonstrate an understanding of the individual learning and social needs of the middle level child. Students grouping practices and understanding by design curriculum encourage students to challenge themselves and be accountable for their learning in the classroom. Classrooms are largely heterogeneous except for Algebra in 8^{th} grade. Students with similar disabilities are placed on the same teams for effective use of the special education staff. For example, students with Autism are placed on the same team so that they can receive similar supports and strategies in inclusion classrooms. The literacy block offer flexibility in student grouping practices and enable Timberlane Regional Middle School to target specific student learning needs. Programs made available to students include Math Counts, and enrichment also demonstrates the awareness of diversity of learning needs in the student body.

The process of clear and consistent communication is evident within the building at Timberlane Regional Middle School. School e-mail and the q drive function as the main vehicle for communication among staff members. The q drive serves as a bulletin board for announcements and district news. The Building Council publishes and disseminates meeting minutes to the staff. The school website is regularly updated with links to the school newsletter, homeworknow.com, and team e-mail addresses. The student agenda is also used as a communication tool for teachers and parents. The school schedule makes it possible for grade level content teachers and interdisciplinary teams to meet to discuss curriculum and teaching strategies, and review student work. The lack of phones in the classrooms hinders instantaneous communication within the building. Parents of the Timberlane Regional Middle School school community stated that they felt that communication with teachers was strong and they “trust” that the administration and the teachers support their child’s education.

Timberlane Regional Middle School has clearly stated, developmentally appropriate standards for student behavior that are conducive to the well-being and safety of everyone in the building. Expectations for conduct are stated in the student handbook. Students and parents must read the agenda handbook and sign off that they have read the school’s code of conduct. The core values of respect, responsibility, and right choices evident on posters and art work are displayed throughout the building. Student discipline embraces the concepts of maturity and responsibility by providing an opportunity for students to learn from their mistakes. Teachers handle consequences by following a common set of guidelines and making referrals to guidance in certain situations in order to address student issues and prevent escalating behaviors. The assistant principals manage discipline in the cases of more serious infractions. The Timberlane discipline model is based on the core values and includes discussion related to those values. Some staff members are still learning to work within that model. The Timberlane Regional Middle School staff and school constituents have seen a significant reduction in school suspensions.

The visiting committee observed positive, respectful interactions with students and staff at Timberlane Regional Middle School. Acceptable behavior is posted and modeled throughout the building. Students mentioned that they felt welcomed and safe in the building. The student advisory and Student Senate provide venues for self reflections and positive behavior that promotes renewal and growth. The advisory gives students a chance to “create a tolerant and caring community of learners” as well as obtain academic support. The Student Senate teaches students to be good citizens by organizing food drives and operating a school store. Students are encouraged to take risks in their learning and fix their mistakes.

Safety is a priority at Timberlane Regional Middle School. There is one main school entrance and all staff members wear identity badges and visitors must wear a guest badge. Parents agreed that their children are “happy and like school”. Timberlane Regional Middle School has a move up day to introduce and orient grade five elementary students to Timberlane Regional Middle School to prepare them for the following year. The Timberlane Regional Middle School staff has a wellness committee that supports faculty members with ideas and tips to stay healthy. Twelve staff members celebrate the accomplishments and hard work of twelve other staff members each month by giving them trophies at the monthly faculty meetings. Timberlane Regional Middle School staff members commented that morale fluctuates due to a combination of perceived new initiatives and differences in team composition.

The members of the Timberlane Regional Middle School school community demonstrate collegial respect and cooperation. Their willingness to share instructional strategies, focus on literacy, and participate in the school advisory shows their motivation and common purpose to foster student achievement. The grade level teams use the core values as a basis for an individual team identity and conduct team activities to provide students with self-esteem and ownership in their teams. One of the teams uses their name and mascot as the basis for an interdisciplinary unit. It is clear that the staff and students take pride in the school facility as it is clean and space, while limited, is maximized to its fullest potential. There is strong evidence from parent meetings of respect and trust for the principal and staff for maintaining a high quality learning environment.

The Timberlane Regional Middle School school community successfully recognizes the social and academic achievements of the students. Student work in the form of language arts assignments, art, projects reflecting the core values are widely displayed throughout the school. Each team nominates a student of the month and character of the month who is then rewarded with a celebration breakfast and a bumper sticker that says "My Child was Student of the Month at Timberlane Regional Middle School". The school personnel is regularly acknowledged and celebrated at monthly faculty meetings where staff members award trophies to their peers for hard work and exceptional achievements.

Timberlane Regional Middle School has a clearly defined and professional evaluation process for the evaluation and supervision of the faculty, staff, and administration rooted in the district and school improvement plan. The teacher evaluation plan coincides with the State of New Hampshire teacher evaluation requirements. The goals of this process are derived from Charlotte Danielson's effective teaching practices. All evaluators are trained in Ribas' Teacher Evaluation That Works evaluation tool. There are five evaluators at Timberlane Regional Middle School. The three assistant principals evaluate the regular education teaching staff, and the special education department head evaluates the special education teachers. The Principal evaluates the ancillary faculty members in the building. Music and athletic teachers are evaluated by their directors who are housed in another building. There are also evaluation plans to support teachers under continuing contracts. Timberlane Regional Middle School educators are expected to seek professional development opportunities in order to stay current in their teaching practices.

Timberlane Regional Middle School has a planned orientation program for administrators, faculty, and support staff. The school board, administration, and school community support the philosophy of increased student achievement through attracting

and retaining quality educators. The Mentoring Program for new teachers or teachers new to the district is comprehensive and provides support for teachers so that they can be successful professionals in the district.
There is uniform agreement among the Timberlane Regional Middle School staff that the Mentoring Program is valuable for teachers new to the profession or new to the school. The idea was raised about the possibility of a district orientation for substitutes.

Timberlane Regional Middle School has an all-encompassing crisis/emergency response plan that includes fire drills, lockdown, and evacuation procedures and drills. Each classroom is equipped with emergency backpacks that include exit maps and student seat assignments for evacuation to the Timberlane Performing Arts Center. The guidance secretary has pertinent student back up information for emergencies and evacuations. The school routinely reviews emergency procedures. Timberlane has a district safety committee that helps to sustain a secure entrance and learning environment at Timberlane Regional Middle School.

The parents, teachers, and school community members of Timberlane Regional Middle School have expressed an overwhelming sentiment that they feel welcomed at the school. The PTSA and Building Council are encouraged with opportunities to participate in decision making centered on what is best for students. Staff members mentioned that the principal is open to discussion of team and building concerns. Parents remarked that they appreciate the opportunity that their children have to explore new academic interests in a non-threatening learning and social environment. One parent commented on how her child enjoyed the ability to take a full year of a world language and would continue those studies at the high school level. The parents agree that they felt students were getting adequately prepared for their furthering their educational experience.

Professional development is coordinated at the district and building levels. The district professional development program collaborates with two teachers in the building and the curriculum coordinators to ensure that ample professional opportunities are available to meet the needs of the staff. Teachers are also encouraged to attend meaningful professional development workshops and provide workshops on areas of talent or expertise. The curriculum coordinators also give impromptu workshops based on teacher requests. The staff at Timberlane Regional Middle School is enthusiastic and turnout for professional development workshops is high. There are half days one time per month used for teacher in-service and conferences. Teachers are required to track their professional development on My Learning Plan, a professional development tracking program.

COMMENDATIONS

The visiting committee commends Timberlane Regional Middle School for the following:

1. The dedication of both teachers and administrators to creating a positive and nurturing learning environment
2. The support and leadership by example of the principal in maintaining an environment based on the core values of respect, responsibility, and right choice
3. The opportunities for collaborative leadership
4. The development of a schedule designed to meet the needs of both students and teachers
5. The positive impact of the advisory program for many students and staff
6. A strong commitment to good communication both internally and externally
7. The empowering of staff, students, and the parent community to grow as leaders and good citizens who support each other in the school community
8. The celebration and recognition of students and faculty members

RECOMMENDATIONS

The visiting committee recommends the following:

1. Ensure the success of the Advisory program through discussions and setting expectations
2. Create additional opportunities for open ended sessions about a student centered environment
3. Create more opportunities for content teacher across grade levels to grow as a professional learning community
4. Provide more access to phones to maintain communication with the home

SCHOOL RESOURCES FOR LEARNING

OBSERVATIONS AND CONCLUSIONS

Timberlane Regional Middle School has a wide variety of student support services to ensure that each student has an opportunity to achieve the school's expectations for academic achievement and social development. These supports include, but are not limited to: guidance, student assistance program, health services, special education, literacy supports, enrichment, after school activities, library and media services, advisories and summer programming.

In response to NECAP test scores, Timberlane Regional Middle School has made a strong commitment to offering a multi-tiered response to reading interventions. The Read 180 program and Language! are taught by certified special education staff and serve to target student who are not reading on grade level. These programs are offered in addition to their regular language arts classes.

The students that attend the Read 180 program are a combination of identified and regular education students; the program is offered for one block each day. The Language! program is taught over a double block (90-minutes) to identified students. Students attending Language! must give up their unified arts block. Staff have praise for the commitment of resources to the reading interventions, but lament about the sacrifice of unified arts that the students must make.

There is a three-fifths reading specialist who guides the Language! program, leads initiatives and provides direct service to a few students. At least one para-educator has received some formal Wilson training and delivers this reading intervention to a couple of special needs students.

In addition to the four core academics, students have a fifth core block which is used to support literacy. During this block, some students are targeted for math or reading interventions (as noted above). The majority of students appear to rotate among the grade level content teachers. For example, one group of students researched information on the presidential candidates with a social studies teacher, another group studied forensics, and another group was offered an art activity. Although the reading interventions appear to be uniform among the grade levels and teams, the manner in which the literacy block is used at the team levels appears to be up to team discretion and may not provide all students with an equal experience.

Timberlane Regional Middle School employs a full-time enrichment teacher. This resource is used to support reading and math. Being a large school, this resource is offered to teams for a portion of time during the year, generally during their literacy blocks. One team opted to use the resource to reduce the numbers of students each teacher had. Another team opted to offer an advanced reading group to a targeted group of students. A third team offered two alternating 6-week blocks in accelerated math and language arts. Interviews with staff suggest that while there is appreciation for the resource, it has not been clearly articulated how the enrichment teacher should be best utilized to support student achievement. Parents interviewed were unclear about how the needs of the higher performing students were being met.

There are approximately 220 identified special education students representing nearly 20% of the student population. A broad spectrum of special education supports are in place for the school community. To the extent possible and/or appropriate, students with like disabilities (i.e., EH) are grouped onto the same team to facilitate access to the appropriate special education staff. A newly renovated wing houses supports for students on the Autism Spectrum Disorder. This wing also has space for physical therapy, occupational therapy, speech and language therapy and life skills. A low-intensity learning center exists to support students with such disabilities as developmentally delayed.

There are three teachers for the emotionally handicapped, one dedicated to case manage students at each grade. The staff recognized the need for students in this population to have a place to go to when they needed to regroup or timeout from their regular classes. On their initiation and with administrative support, they formed the STAR program, which provides the EH identified students with a quiet and private space to process behavior. Staff provide both behavioral interventions and support with their school work. Staff report that there has been a tremendous reduction in discipline among the EH population in response to this intervention as students are able to remain caught up and ready to go in all of their classes. The visiting committee observed this in progress and were able to understand the benefits.

There are sufficient special education staff and paraprofessionals to support identified students. All students who are identified in their IEP's as needing paraprofessional support have access to that support. Some teachers would like to have additional general paraprofessionals available to support students with learning disabilities within the classroom. In their quest to provide differentiated instruction for students, it would be beneficial to have help to ensure that no one is left behind.

Learning centers are also available for students to receive support with organizational skills, pre-teaching, re-teaching, and homework support. Students who might benefit from this support do so on alternating days opposite PE and do so in lieu of a unified art or foreign language.

Bridges is a program that targets at-risk students. These students have not been assigned an IEP, but staff recognize that without targeted intervention or supports, these students may not succeed in school. Three certified special educators, one per grade level, are assigned to case manage these students. These students are identified by teachers in the spring, and with parent consent, assigned to the team in the fall that will house the Bridges program. Supports include: in class academic supports, daily homework updates, structured study hall, goal setting, organizational supports, afterschool help, behavioral supports, home-school communication and more.

The guidance department is well staffed and offers an array of services and supports. Each grade level has a dedicated counselor who loops with students throughout their three years, allowing for continuity of information and relationship with students and families. Counselors offer small group guidance, such as mood and anger management, adoption issues, social skills and the like. Classroom guidance is offered periodically to the grade levels and teams, such as a 3-session unit on stress management and reduction.

In addition, Timberlane Regional Middle School has a full time Student Assistance Counselor to support at risk students with such topics as drug and alcohol issues and peer mediation. Timberlane Regional Middle School also employs a Student Adjustment Counselor who primarily supports the EH population.

Each month, the guidance secretary sends out e-mails asking staff to nominate students for Student of the Month (academic focus) and Character of the Month (citizenship focus). These students are announced to the school community, invited to a brunch and receive a bumper sticker.

Timberlane is in third year of offering an advisory program to students. The majority of professional staff members and administrators meet with a small group of students each morning. Goal setting, organizational support, leadership, relationship building, easing into the school day and reinforcement of the school's core values of respect, responsibility and right choices are some of the foci of the advisory program. Multiple staff members cite the advisory program as having had a direct role in reducing student discipline and contributing to the positive school climate.

Guidance staff meet weekly with each team to discuss the needs of students. Guidance counselors and the nursing staff meet biweekly, allowing them to share information on students. Every other year, the guidance staff invite area therapists into school for a bi-annual counselors brunch. This is an opportunity to meet therapists, to find out what their area of specialty is, which, in turn, allows guidance staff to better work with parents when making outside referrals.

For students with medical needs, nursing staff create medical care plans and communicate these plans to staff.

The professional special education staff meet at least weekly with their respective grade level team, although sometimes this is challenging as the team meeting time is also the time special education staff are needed to run the guided study halls with identified students. The three EH teachers, who are not assigned an advisory, meet each morning to talk about their students, targeting the day's resources on students who may be in crisis. So as to be able to respond immediately to students in crisis, this group of teachers carry walkie-talkies as classroom telephones do not exist.

Among the professional staff, teachers who support students felt that there was ample opportunity to coordinate efforts with grade level teachers. However, some teachers, such as the Language! teachers who teach three 90-minute blocks are unable to connect easily or adequately with the grade level teams of the students they case manage. In these instances, other special education teachers, already with a full case load, step in to fill in the gap.

Among the paraprofessional staff, there were differing views about the level of communication and collaboration among staff. Many paraprofessionals feel supported and highly valued, have ready access to their case manager, have good information on the students they support and clear direction. Others feel they have unanswered questions, unclear direction, and a lack of information or input into the student's educational day. Other concerns brought up, relating to pay and working conditions are beyond the scope of this study, but may be exacerbated as some paraprofessionals who feel isolated. Most paraprofessionals are only employed for 6.25 hours a day, which limits preparation or consultation to a busy and full school day and does not allow for building in time for consultation with case managers.

Teachers seeking additional support for a student may refer the student to the SST, or Student Study Team. Facilitated by a regular education teacher, this team convenes guidance, school psychologists, teachers, parents and administrators together to strategize around supports for specific un-identified students. If the interventions are not successful, students may then be referred to the SEEPT, or the Special Education Early Prevention Team for possible further assessments.

The newly renovated wing houses support services for the ASD, or Autism Spectrum Disorder population. In addition, this wing includes appropriate spaces for physical therapy, occupational therapy, life skills and some speech and language therapy. Throughout the rest of the school, every available space is fully utilized to capacity. Walls were built in a classroom area to allow smaller instructional spaces for the Language! programs. Speech and language staff shared that they sometimes struggle to find a quiet and private spot for therapy. Special education teachers are able to use empty classrooms during the unified arts block to support students with their academics but struggle to find private locations to conduct their three-year reassessments and evaluations.

Each guidance counselor has a small, but private office available to them. As the waiting area is in close proximity to the offices, when students or guests are waiting in the guidance foyer, the secretary turns on a white noise machine to ensure privacy and confidentiality.

The two school nurses have small, but private offices available to them. Students who come in to the health services area to check blood sugar, take asthma medication or other medications, must work off of a counter in the main room where the nurse secretary is stationed. There are presently two beds available in the nursing area and staff feel that four beds are warranted.

School records are housed in private and secure areas. Cumulative files and 504 files are stored with the appropriate grade level guidance counselor. Special education records and confidential files (both active and inactive) are stored in the main office. Health files are stored in the school nurse area.

With limited telephone availability, e-mail is the primary form of communication between school and home. Parents report that staff are prompt in returning messages. Several of the special education staff were observed using e-mail to communicate with parents about the night's homework assignments and/or missing work. In addition, Bridges staff send home bi-weekly update sheets on their students. Timberlane Regional Middle School maintains a current and up-to-date website with links to the principal's newsletters, to the guidance department and its related resources, to Homework.now, and more. More specific information about student support services is made available during the SST (Student Services Team) process, when interventions are being discussed between school and parents.
The Bridges staff is working on a parent brochure and binder that will contain information about the supports available via this program. Parents expressed that they felt knowledgeable about school practices, programs and support services.

There was ample evidence of evaluating and/or collecting data on students. For example, students in the Language! program take summative assessments at the end of each level. Some special education teachers, such as the EH teachers, keep data on students regarding such things as: when they are sent from class, times of day events occur, homework completion and the like. Nursing staff keep data on the number of students accessing health services and the nature of their visit. Efforts to create new programs, such as literacy interventions and the STAR program for EH students were driven by available data that a need existed.

Timberlane has a sufficient number of certified and licensed personnel and support staff as follows:

Guidance: Timberlane Regional Middle School has four full-time counselors, one per grade, plus one Student Adjustment Counselor who works with the EH programs. In addition there is one Student Assistance Counselor who is a licensed drug and alcohol counselor.

Nursing: Timberlane Regional Middle School has two licensed nurses.

Special Education: A wide variety of certified special educators, both general special education and disability specific, such as with the EH program, are employed at Timberlane Regional Middle School. The administration has employed certified special educators to support the Bridges program for at risk, non-identified students, as well as to run the literacy intervention supports Read 180 and Language!. Certified and licensed occupational therapists, speech and language therapists, and physical therapist deliver services to students. Three part-time school psychologists are utilized for social-emotional and intellectual assessments.

Reading: A part-time, certified reading specialist is employed to help oversee the reading intervention services.

Interviews suggest that the school community finds the support staff to be both well qualified and sufficient. Some regular education staff commented that they would like to see more paraprofessional support for the students with specific learning disabilities. Some of the paraprofessional staff feel they are being asked to perform duties (ie make modifications, teach math and/or reading skills, assist with health care, etc.) for which they have not received adequate training. The District encourages the special education paraprofessional support staff to become certified by offering courses, stipends for workshops and a small pay raise for gaining and maintaining paraprofessional certification.

Timberlane Regional Middle School’s three counselors provide a wide range of services. Individual meetings with students occur throughout the day. Students can access the counselors during lunch, unified arts blocks, and the grade level teachers are generally gracious about allowing students to access the counselors during class time when needs arise.

Small groups are offered in response to need, such as divorce support, social skills, relaxation, adoption issues, anger management and the like. Large group instruction is periodically offered to the teams at different grade levels. One counselor offered to come in and conduct lessons during the early release days. Another counselor, working with the Student Assistance counselor, conducted a three-session series on relaxation

Counselors loop with students so as to be able to provide a continuity of support to students and their parents, as well as to be able to convey information from one grade level to another.

School counselors meet bi-weekly with the school nurses, and weekly with the special education staff. Referrals to community resources are made when appropriate; a directory of available community therapists and services is available in the guidance office and updated bi-annually via the counselors' brunch. The guidance department also has a budget available to them for conducting parent workshops. Last year a couple of the parent workshops included divorce support and one on teen depression. This year they offered a NHEAF early college planning workshop and they are planning a parenting your adolescent workshop.

Timberlane Regional Middle School is in its third year of offering an advisory program. To keep the numbers small and manageable, nearly all professional teachers, guidance counselors and administrators maintain an advisory. Advisories provide students with opportunities to be known personally by at least one adult, and to be supported and known within a small community. Some eighth grade students are able to sign up for leadership advisories. On occasion, these students run advisory activities for sixth graders. The Student Assistance Counselor also trains some students in peer mediation, and when appropriate, may bring younger students together with older peer mediators.

A comprehensive after school enrichment program, supported by a late bus three days a week, allows students to be known and to belong to a small community. Some of the after school opportunities also include: dance, Lego building, Student Senate, Math Counts, and more. Both intramural and interscholastic sports are presented as options for students,

Guided study halls, which offer homework supports to at risk students, are offered via the Bridges program.

The library and media area, staffed by a certified media generalist and two library assistants, presents a welcoming environment that has space for one class to use the facility at a time. Due to the somewhat small size of the facility for the student population and the limited computer terminals (15 computers), limits are set regarding the number of students who may go to the library to use computers, conduct research, check out books or sit and read. The openness of the library to the hallway and passing student traffic is not always conducive to lessons and instruction. There is o intercom in the library.

The library is readily accessible to students. Students may access the library to browse for books, to conduct research, to use computers, to sit and read periodicals and more. Students report that they can easily access the library during advisory and after school.

Other students access the library during class, such as when they have completed work or assessments. During the visitation, students were observed using the facility for independent reading, for collecting research, and several classes were observed receiving large group/ class instruction on research skills relating to one of their content classes. Both in the self-study and through interviews, it was noted that not all teachers utilize the library media services, which might contribute to unequal educational experiences for students.

The library and media personnel are highly regarded by the school community. Personnel are knowledgeable about current books and literature, about curriculum being taught at the various grade levels, and about current media such as mp3 pocket books and digital camcorders. Several staff interviewed expressed that they can approach the library staff with any idea or project, and that the library staff respond with ways to integrate research and/or suggestions for materials. The area is well maintained and attractive, featuring displays of student work and classroom projects.

Working in collaboration with classroom teachers, research skills are taught to students using the curriculum content as the vehicle. Using input from teachers, great efforts are made to purchase materials that support the curriculum. The collection, while not huge, is current, of good quality and diversity, and appropriate for a wide range of learners and readers. Materials include books, audiocassettes, periodicals, DVD's, MP3 Play-a-Ways, professional materials, and more. Students have access to electronic databases which is supportive of their research quests. If something is not available at the library, the staff will seek to access it from the high school which increases student options for materials and equipment. Computer terminals are present and accessible for students and teachers in the library.

Selection and removal policies are in place and have been effective in assisting school staff in dealing with parental challenges for the removal of materials. Policies are periodically reviewed at the District level and are readily available to the public via links on the Timberlane Regional Middle School web site.

The Internet Acceptable Use Policy has been effective in guiding the appropriate educational use of the internet among students and staff. Timberlane Regional Middle School staff who participated in this portion of the self study articulated their concern with student use of electron ic information and plagiarism and expressed the importance of continuing efforts to address the issue. The visiting committee notes that efforts to teach research skills via content/grade level projects are steps towards this concern.

The school's health services include two licensed nurses and secretarial support. Having two nurses allows staff to respond quickly to students. All visits are logged, including information about the nature of a student's visit and outcome or care plan. Should one nurse see a student and the other, the same student on a different day, the computerized log allows the nurse to quickly pick up where the other nurse left off. It was reported that an average of about 60 student visits occur each day.

The nursing staff conducts all annual screenings as required by law, such as vision and hearing screenings, and scoliosis screenings. Additional screenings are conducted at the request of special education staff or parental requests. Screenings occur in the corner of a room shared with two beds; nurses report that conducting screenings can be difficult when there is other activity in the health services area.

The nursing staff creates health care plans for students with diabetes and allergies, and disseminates these plans among staff. In an effort to address the growing number of students with allergic responses, the nursing staff has posted signs reminding staff, students and visitors that certain areas need to be "nut free" and "fragrance free."

The nursing staff assists parents when referrals are appropriate. Nursing staff regularly meet with guidance staff to share and coordinate information.

All health records are maintained in a confidential and secure manner.

COMMENDATIONS

The visiting committee commends Timberlane Regional Middle School for the following:

1. The communication both among the student services staff, and between the staff and families
2. The ample and broad variety of support services for students, including certified, professional and paraprofessional staff
3. The commitment to literacy support for students performing below grade level
4. The Bridges program which supports at risk students
5. The STAR program which has reduced discipline issues among the EH population
6. The full array of guidance services including grade level counselors, a Student Assistance Counselor and a Student Adjustment counselor
7. The bi-annual Counselor's brunch
8. The Character of the Month and the Student of the Month recognition awards
9. The use of the SST and the SEEPT to develop and support student interventions
10. The staff's flexibility and willingness to share finite building space
11. The wide array of after school opportunities for students

12. The highly effective library media program
13. The commitment to providing special education services in accordance with the spirit of laws and mandates
14. The effective advisory program

RECOMMENDATIONS

The visiting committee recommends the following:

1. Develop a more common understanding and use of the literacy block among the varied teams and grade levels
2. Clarify how the enrichment teacher will be utilized to support student learning
3. Devise and implement a process to ensure all paraprofessionals have access to supervision and sufficient information regarding the students they support
4. Address the space needs for supportive services annually to ensure that the building is used on a maximum level

COMMUNITY RESOURCES FOR LEARNING

OBSERVATIONS AND CONCLUSIONS

The Timberlane Regional School Board represents the communities of Plaistow, Sandown, Atkinson and Danville, New Hampshire, with representation proportionate to the individual populations of each of the four communities. The board is responsible for all public education K-12 and meets regularly to conduct its business. Its work is delegated to a series of committees, each of which works separately from the board as a whole and reports back when appropriate. Among those committees are a policy committee and a budget committee.

The policy committee is charged with presenting policy in either a pro-active or reactive form. It responds to the needs of the school and the district and uses policy to deter potential issues or resolve others. If an existing policy needs to be addressed or if one needs to be created, it is developed or reviewed by the policy committee. The committee seeks administrative input and posts the information on its web site and local television station for public viewing and response. Finally, the board acts on the item and, if passed, implements it.

The budget committee oversees the budget process, which is directed by the superintendent of schools. The superintendent sets the parameters and asks the principals to develop a budget within them. Teachers meet in teams to decide their needs for the year. Curriculum Coordinators for each grade level accept requests for materials from the teachers. This information is compiled into a grade-level budget and is then submitted to the building administrator. An exception to this is in the Unified Arts Department (Technology, Art, Music, Physical Education and Foreign Languages), in which the instructors for each subject area across all three grades develop their own budgets and submit them to the assigned Curriculum Coordinator for review. The building administrator then reviews all budgetary requests and makes adjustments as seen fit. The revised budget is then submitted to the Superintendent of Schools, where further review and adjustments occur. The Superintendent then sends the proposed budget to the elected School District Budget Committee who reviews and recommends the budget to the School Board. The School Board then recommends either to support or not support the budget, and then a warrant is issued. A public hearing is held in January before taxpayers finally vote on the budget during Election Day in March. If denied, decisions are made by the administration to make cuts where appropriate. The driving force of every stage of this process is to ensure that the needs of Timberlane Regional Middle School students are being met. According to board members, community support has been very high over many years, and the budget has not been voted down in recent memory.

The public support of the budget process is helped by the transparency of the process. Its clarity enables the community to see that the focus of the budgetary process is set on the students and the school buildings, so the community responds positively.   New programs are included when appropriate; personnel is added or lessened according to need; materials and supplies are purchased in support of the programs. The school board, through its budget, supports the school by considering the requests made by staff and administration, prioritizing them with others within the district and making decisions within the fiscal limitations imposed on them.

The faculty and administration of Timberlane Regional Middle School are satisfied with the budget process and believe their needs in the areas of materials, programs and professional development opportunities are being met generally which, in turn, enables them to support the students. The self study contains a four page listing of programs, processes and systems which have been supported continually by the community and school board through its budget. The list is long and reflective of a district that supports its students and their teachers. While updates to the facilities have been supported, such as adding the 8th grade wing and creating the ASD suite, the building is not appropriate for a true middle level program, and its infrastructure is in need of much work. This leads to the inevitable question of renovation versus construction and the costs inherent in both. Since there have been plans to move forward on a building project which would directly impact the middle school, the anticipation of those plans has reduced the anxiety associated with minimal spending on the building.   The school board is clearly aware of the issue and is working through the budget process to address those issues in a timely manner. However, the lack of space, photocopiers, phones, computers and network issues directly affect the delivery of academic and social services.

Both the school and the school district have adopted planning models for a variety of initiatives as well as maintenance of those already in place. The school board and superintendent have, in the past three years, initiated a series of planning programs designed to address the current and anticipated needs of the district. The district acknowledges the need to review facilities K-12 in order to ensure a continuous flow of excellence. NESDEC was hired to develop a long range facility master plan which, for the purposes of this report, identifies a number of issues pertaining to the middle school facility and a tentative plan going forward twenty years is being formulated at central office.

In addition a five year strategic plan is being developed, the focus of which is a determination of what the district wants to be known for. This focus will serve as a guideline for program and staffing planning in the future. A capital improvements plan is being considered.   The school board and superintendent have discussed the limitations of the economy and the ability of the different towns to pay in considering each of these planning documents. Further discussion will be necessary before final decisions can be made.

The middle school has developed a strategic plan as well which is predicated on the building. .It includes the components of staffing, educational services, capital improvements, technological resources and professional development. Within the strategic plan is a sub-plan to address technology. The technology mission of the school is to incorporate technology into the educational programs to support curriculum, develop critical thinking, communicate effectively, expand the learning experience, and to make sure students and staff have adequate access. The three year Technology Plan was put into place to help in the replacement of outdated computers, printers, and software. The plan involved adding two mobile wireless labs, more digital still/video cameras and more LCD projectors. Maintenance of current online databases for research, as well as additional software with site licensing to support curricular areas, is ongoing. The district is currently working to complete a five year technology plan.

The school recognizes that parents can and should play an integral part in the academic and social growth of their student. Teachers at Timberlane Regional Middle School want to engage parents and work together to keep them informed. Some teachers feel the system of documents going home with students needs improvement, since parents may not know it is coming, things do not get returned and information is missed. Parents are welcomed into the school to volunteer, meet with staff regarding their child and to participate in PTSA boards, parent conferences and open house. The guidance department also sponsors workshops pertaining to the child's well being which are focused on the parents' role in the educational process... While these volunteer opportunities are encouraged and available, some staff members think there could be more parent involvement in these areas.

Parents are encouraged to be actively involved in helping their child choose courses as they enter their freshman year. Access to school information, such as homeworknow.com is available on the school website and on the TEN network, the local television station. Parents are encouraged to communicate through phone calls, emails, and meetings. Conversations with parents resulted in commendations for the staff and administration for their promptness in returning phone calls and emails, but, the absence of private spaces in which to have these conversations is limited and acts as a hindrance to effective communication. Parents feel welcome at the school which is a tribute because this administration has changed the approach to working with parents to be more inclusive.

Timberlane Regional Middle School draws its students from four towns, so its relationship to a single community has its limits. Local businesses have participated in a Career Day, and both Anton cleaners and Hannaford Foods have been supportive of various programs. Through the Student Senate, the students have reached out to the community and participated in various charities such as the cancer walk, Toys for Tots and senior citizen events. A new Leadership Advisory is focused on providing leadership opportunities for the students during their middle level years. Although it is new, this particular Advisory has engendered a great deal of interest and it has enabled students to focus on acting out the school's core values and working as peer leaders to other students in the school.

The facility is over thirty years old and has a stated capacity of 700 students. At the time of the visit, the enrollment was over 1100. The teachers and administrators creatively make full use of every space in the building, but it is clearly not conducive to the effective delivery of a comprehensive middle school program. A recent study conducted by NESDEC identified a series of issues including, but not limited to, the size of the gymnasium, the library, large group spaces, storage areas and science instruction. The infrastructure and ancillary spaces also need to be addressed. There is insufficient parking; the internal communication system is broken; hallways are congested; there is limited meeting and preparation space for teachers; the cafeteria is inadequate; and many classrooms are less than 900 square feet, inappropriate for productive interactive middle level learning. Of particular note is the fact that some of the science labs do not have eyewash stations and those that do have installation issues that need to be addressed.

In addition the lack of classroom space impacts quality of instruction because some teachers have no permanent rooms, forcing them to live out of carts and move from room to room. While this may not seem to be a hardship, it becomes one when the overcrowded situation comes into effect. The moving of carts and materials creates a safety issue because of the numbers of students in the hallways during passing time. It slows the moving considerably and lessens the amount of time on task necessary to good learning.

The communities have been aware of the limitations of the building for some time and have provided funding for projects which allowed for temporary repair and additional space. Nonetheless, the problems have not gone away, and it is important to the continuing success of the middle school to review the overall state of the building and set a course of action to ensure that the building supports the middle level programs which are basic to the education of the students. The building itself was not constructed with twenty-first century middle level students and/or programs in mind which also is a impediment to the overall mission of the school. New programs require more space; new teaching techniques need different kinds of space.

The building also is faced with air quality issues, which affect both students and teachers. The problem is acknowledged by the administration, but a solution is not imminent until the status of the building is determined. The exterior of the building has play areas, most of which are not conducive to middle school activities; the roof, although repaired, is in need of further attention; most clocks and intercoms in the building do not work correctly.

Timberlane Regional Middle School has one full-time day custodian and one part –time, with a crew of five that works at night. All custodians and maintenance workers have fire safety training made available to them. The staff is adequate for the square footage of the building and it is well maintained. Through MaintenanceDirect, a work order management system used district-wide, the school may enter and track work order progress. Most work orders at the school are filled out by the office business secretary as opposed to individual staff members. If a staff member has a maintenance need, they send that through the office. Some staff members mentioned that work orders aren't always done in a timely manner, but, at the same time, explained that it is often due to the fact that the work order goes through the central office, then back to Timberlane Regional Middle School custodians. However, most agreed that the building maintenance is satisfactory. If a work order is placed that is a safety issue it is treated as a priority and completed as quickly as possible.

At the same time, the custodial and facilities staff keeps the building immaculate. Using a system of constant clean up during the day keeps the custodial staff ahead of the normal messiness caused by the movement of over one thousand students all day long. The students are proud of their building and see its cleanliness as their responsibility. Nonetheless, the custodial staff is to be commended for their commitment to the building and the students.

Timberlane Regional Middle School is in compliance with state and federal laws regarding fire, health and safety. The building is checked on a regular basis, and every August it is inspected in order to issue an occupancy permit for the school year. Evacuation and fire drills are set up four times per year according to the recommendation of the fire chief. The visiting committee observed a fire drill in progress. Both students and teachers were practiced and ready.

The school lunch program is administered by an outside agency. School lunch is served between the hours of 10:30 AM and 1:25 PM. A recent change in the flow of students to the cafeteria has smoothed out the overcrowdedness and the confusion caused by too many students in a small cramped space. The room itself was expanded by altering its current structure, providing more space for dining. In addition, a recess period was added to the end of the lunch time, which moves the students along more quickly. Students are offered a variety of choices and cold drinks, and the food service is in compliance with all federal, state and local regulations. Workers follow strict regulations for health and safety and at least one person is "Serve Safe" certified. Nutrikids/Powerlunch system provides a way for parents to pay for and monitor what their child is eating at lunch.

The Timberlane School District contracts with First Student Bus Company for all district transportation. Each driver is required to be licensed and qualified to meet all driver guidelines and regulations. There are 14 buses that move in and out of Timberlane

Regional Middle School to transport middle school students to four different towns. The busses line up in an orderly and sensible way to make for loading and dropping off students safe and manageable. The visiting team observed the bus procedure at the beginning and end of the school day, and determined that the process runs smoothly and is very workable. The distance between school and home can cause a student to be on the bus a better part of an hour, and it is in the best interests of the students and the school to try to recduce the length of the ride.

COMMENDATIONS

The visiting committee commended Timberlane Regional Middle School for the following:

1. A school board that is supportive of middle level education
2. The continued support for the budget by the community
3. The development of a five year strategic plan
4. The establishment of a budget process that is inclusive of teachers and building administrators
5. The construction of the ASD suite to enhance educational opportunities for students with special needs
6. The establishment of separate bus routes for middle school students
7. The well maintained and clean facility
8. The creative utilization of space

RECOMMENDATIONS

The visiting committee recommends the following:

1. Develop and implement a plan for renovation and/or new construction to resolve the myriad of building issues that affect the Timberlane Regional Middle School program, using the NESDEC report as a guideline
2. Repair safety equipment in the science labs
3. Increase the number of phones for teacher use in calling student homes
4. Develop and implement a plan to improve outdoor play areas
5. Develop and implement a current plan to repair the roof
6. Develop and implement a well-articulated long range plan for technology access for teachers and students
7. Implement a current plan to test air quality and address any resulting recommendations
8. Implement a current plan to improve communication in all rooms in the school
9. Develop a process to evaluate the effectiveness of parent/school communication strategies on an annual basis

CONCLUSION

On behalf of the Visiting Committee I commend all those who contributed time and energy toward the completion of the self-study, as well as toward the preparation and hosting of the peer review team. We have enjoyed participating in this professional experience with you.

We hope that this visiting committee report, in conjunction with the strengths and needs determined during your self-study, will serve as rich resources for your short and long-term planning and that they will assist you as you continue to strengthen education for your students.

Upon your receipt of this report, you should review the Commission's guidelines for dissemination, action planning, and follow-up. It is suggested that the school appoint an action planning committee or steering committee to review the visiting committee report's recommendations and to divide them into meaningful categories - whether according to the Standards or according to another relevant format. However the recommendations are divided and whatever timelines are drawn, the follow-up process must remain relevant to your particular school.

As previously stated in the introduction, this report has also been mailed to the Commission on Public Elementary & Middle Schools' Committee on Middle Level Schools for an in-depth review and recommendation regarding accreditation. The recommendation will then be forwarded to the Commission itself for final approval. Depending upon the Commission's recommendation, the school may be requested to submit one or more special progress reports in the years prior to, and following, the five-year report. At the five-year mark the school must submit a report explaining the status of all the team report's recommendations - whether completed, in progress, planned for the future, no action as yet, or that the school feels the recommendation should be rejected.

Once again, on behalf of the visiting committee, please accept our esteem and respect. You do wonderful things for the children of your four towns in the face of all the restrictions put on you by government, economics and diverse educational philosophies. For Timberlane Regional Middle School, the bottom lines are those students who walk through the door every day. You do that well.

<u>Timberlane Regional Middle School</u>

MISSION STATEMENT

The Timberlane Regional Middle School is committed to sustaining a collaborative learning environment so that our students may become successful, independent learners. It is our mission to:

- **Provide a safe, respectful, and nurturing environment that encourages enthusiasm for learning.**
- **Foster responsible citizenship and provide opportunities for students to acquire and demonstrate leadership and service.**
- **Provide a challenging, integrated, standards-based curriculum.**
- **Meet the individual needs of students by identifying differences and using assessment to differentiate instruction and learning.**

Timberlane Regional Middle School
Plaistow, New Hampshire
November 16-19, 2008

VISITING TEAM ROSTER

David Flynn, Chair
Director, Commission on Public Elementary and Middle Schools
NEASC
Bedford, MA

Robert White, Assistant Chair
Superintendent (Retired)
West Bridgewater Public Schools
West Bridgewater, MA

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York Middle School
York, ME

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Samuel L. Wagner Middle School
Winterport, ME

Leah Karantza
English/Science
Bonny Eagle Middle School
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Beth Zimmer, Guidance
Gilford Middle School
Gilford, NH

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Rundlett Middle school
Concord, NH

Valerie Fenn, Math
East Hartford Middle School
East Hartford, CT

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Rochester Middle School
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Freetown-Lakeville Middle School
Lakeville, MA

William Warner-Prouty, Social Studies
Sage Park Middle School
Windsor, CT

Ingrid Belitsky, Special Education
Ayer Middle High School
Ayer, MA

STANDARDS FOR ACCREDITATION

Teaching and Learning Standards

Mission and Expectations for Student Learning
Curriculum
Instruction
Assessment of Student Learning

Mission and Expectations

The mission statement describes the school's role as an integral part of the educational community. The mission statement emanates from the school's beliefs about education and its purpose, and leads to a set of expectations enabling the school and its community to assess its effectiveness.

1. The school has a mission statement, which addresses the school's beliefs about teaching and learning and reflects the character of the school, the unique developmental characteristics of the middle level child and the values of the community and its educators.

2. The school has high, clearly stated and measurable expectations for academic achievement for all students. These expectations include a description of the different levels of performance as well as indicators of the successful attainment of each.

3. The school has high, clearly stated expectations for social behavior, which are developmentally appropriate and address the needs of the middle level child.

4. The school community establishes, accepts and supports the mission statement and expectations for academic achievement and social behavior.

5. The school provides observable and measurable examples of adherence to the mission statement and expectations for academic achievement and social behavior.

6. The school sets a clearly defined cycle for the review and revision of the mission statement and expectations to ensure that they adapt to the changing needs of the students and the educational community.

Curriculum

The curriculum is the formal plan designed by the school to carry out its mission statement and to meet its expectations for academic achievement and social behavior. The curriculum links expectations for student learning to instructional and assessment practices. The strength and effectiveness of the curriculum are dependent upon the commitment of the school and district to a continuous process of implementation, review, evaluation and revision of the curriculum which leads to improved student learning.

1. The school's formally written and implemented curriculum is aligned with the school's stated expectations for students' academic achievement and social behavior.

2. Each curriculum area has clearly articulated learning standards that support the school's academic expectations.

3. The content of the curriculum is intellectually challenging, respectful of diversity and allows for the authentic application of knowledge and skills.

4. The curriculum includes coursework, co-curricular activities and other school approved educational experiences which meet the needs of the middle level child.

5. Effective curriculum coordination, integration and articulation exist between and among all subject areas within the school as well as with all receiving and sending schools.

6. There is an ongoing process for curriculum review and revision which actively involves the school's faculty and takes into account the stated academic expectations and assessments of student performance.

7. The written curriculum incorporates classroom and school-wide library resources.

8. The written curriculum incorporates classroom and school-wide technological resources.

9. The school provides sufficient staffing, time, professional development, fiscal resources, materials, technology, and supplies to implement and support the written curriculum.

<u>Instruction</u>

Effective instruction is the single most important factor affecting the quality of student learning. It is aligned with the mission statement and expectations for academic achievement and is the connection to curriculum and assessment, as well as student performance. It takes into account individual student needs, learning differences, interdisciplinary activities and student engagement in a variety of ways. Self-reflection and interactive dialogue with colleagues is necessary to ensure success.

1. Classroom instruction is based on current research and embodies the school's stated beliefs about teaching and learning.

2. Classroom instruction is designed to enable all students to meet the school's high expectations for academic achievement.

3. Instruction facilitates learning by including practices that are personalized, exploratory, self-directed, authentically based, reflective and integrated across the curriculum.

4. Instruction ensures the development and application of higher order thinking skills and problem solving abilities.

5. Instructional strategies incorporate various technologies to improve student learning.

6. The school provides sufficient staffing, time, professional development, fiscal resources, materials, technology, and supplies to support effective instruction.

7. Ongoing discussion of improving instruction as it relates to student learning is a significant part of the professional culture of the school.

8. Teacher supervision improves instruction and enhances student learning.

Assessment

Effective assessment practices ensure that student progress is measured in relation to the school's stated academic expectations. Assessment also provides teachers with opportunities to evaluate and adjust instructional practices to improve student learning. Assessment and its analysis provide the opportunity to develop long and short-term strategies to improve curriculum and instruction across the school. Assessment results inform the school community about school progress.

1. The school utilizes an ongoing assessment system that embodies the mission statement and expectations for academic achievement and measures progress in meeting those expectations.

2. Classroom assessment strategies, reflective of current assessment research, are integrated with instructional practices.

3. Student assessment results are analyzed, discussed and used by the faculty and administration in the review, evaluation and revision of the curriculum and the improvement of instructional strategies.

4. Students are active learners who reflect upon and assess their own learning.

5. The assessment of student learning is communicated regularly to parents through a variety of procedures.

6. There are identified learning standards for each subject area which are the basis for grading and reporting.

7. The school provides sufficient time, staffing, professional development, fiscal resources, materials, technology, and supplies to support effective assessment procedures.

8. The school systematically interprets and reports assessment results to the community.

Support Standards

Leadership and Organization
School Resources for Learning
Community Resources for Learning

Leadership

Leadership is the collaborative responsibility of administration, faculty and support staff to achieve the mission and expectations of the school. The manner in which a school organizes itself, makes decisions and treats its members affects the atmosphere in which teaching and learning take place. The school climate fosters mutual respect, as well as opportunities for reflection and growth among students and staff and welcomes the meaningful involvement of parents and community members.

1. The principal, in conjunction with the educational community, provides leadership by developing and maintaining a vision which ensures a focus on the academic and social growth of the middle level child.

2. Professional and support staff share the responsibility for implementing the school's mission and to maintain the academic and social expectations for students.

3. The principal provides meaningful opportunities for the staff to assume leadership roles.

4. Student grouping practices reflect an understanding of the unique learning and social needs of the middle level child and demonstrate an awareness of the diversity of the student body.

5. The school implements a process of clear, consistent and meaningful communication within the building, within the district and throughout the community.

6. The school establishes developmentally appropriate rules and consequences for student behavior that ensure the well-being and safety of students, which are understood and supported by the educational community.

7. The school has a climate that is positive, respectful, structured and safe. It is highly energized and encourages growth, change, renewal and constructive risk-taking among students and staff.

8. There is evidence of mutual respect, common purpose and support among all members of the school community.

9. The work, contributions and achievements of all students and school personnel are regularly acknowledged and celebrated and appropriately displayed throughout the school.

10. The school has a clearly defined process for the evaluation and supervision of faculty, staff and administration which is used to improve student learning.

11. The school has a planned orientation and program for administrators, faculty and support staff.

12. The school has clearly defined crisis/emergency response plans and all occupants are familiar with these procedures.

13. Parents, teachers and community members feel welcome at the school. They are encouraged and provided with meaningful opportunities to participate in the school's decision-making process.

14. There is a planned program of professional development, collaboratively structured by administration, faculty and staff which supports the school's mission and expectations for academic achievement and social behavior.

School Resources for Student Learning

Student support services and programs are designed to enable each student to participate in and benefit from each of the educational programs within the school and to meet the expectations for academic achievement and social development. The school provides a range of services which include guidance, library and media services, special education services, and health services.

All Student Support Services:

1. The school provides student support services, programs and resources to ensure that each student has an equal opportunity to achieve the school's expectations for academic achievement and social development.

2. The school's student support services are designed to support the learning and emotional needs of the middle level child and are consistent with the school's mission and expectations for academic achievement and social development.

3. Student support services personnel interact and work cooperatively with other school personnel and community resources to address the academic, social, emotional and physical needs of the middle level child and to enhance student learning opportunities.

4. The school's student support services programs are housed in areas which are appropriate to the support provided and ensure privacy and confidentiality.

5. There is an effective and ongoing system of communication with students and parents which keeps them informed and knowledgeable about available student support services.

6. All school support services for learning are regularly evaluated, reviewed and revised to support improved learning.

7. There shall be sufficient certified/licensed personnel and support staff to provide effective counseling, health and special education services.

Guidance Services:

8. The school shall provide a full range of guidance services, including: individual and group meetings with guidance personnel; student course selection assistance; collaborative outreach with community mental health agencies and social service providers; and appropriate support for the delivery of special education services for students

9. There are opportunities for advisories, teams, and students to receive peer and adult support through small communities (i.e. teams, group counseling) and through various programs that instruct and/or counsel students in effective decision making.

Library/Media Services:

10. The library and media services program is housed in an area with adequate physical space and is staffed by professionally trained and qualified personnel and supervised by a certified library/media specialist.

11. The library and media services program is readily accessible to students as an integral part of their educational experience, fostering independent and collaborative learning, and supporting the research needs of the students.

12. Library and media services personnel are knowledgeable about the curriculum and support its implementation and integration.

13. A wide range of materials and information resources is available to students and faculty in a variety of formats, to meet the learning needs of the middle level child and to improve teaching and learning.

14. Policies are in place for the selection and removal of resources and materials and the use of technologies and the Internet.

Health Services:

15. The school's health services include:
    - preventive health services and direct intervention services
    - emergency response
    - ongoing student health assessments
    - appropriate referrals

Special Education Services:

16. The school provides special education services related to the identification, monitoring, and referral of students in accordance with local, state, and federal laws.

Community Resources for Student Learning

The community supports the school by providing consistent and sufficient funding for programs, services, personnel, and facilities. It sustains a learning environment that ensures the safety and well-being of all students. Active community and parent involvement is essential for the achievement of the school's mission and expectations.

1. The community, through the district's school board, sets and implements district and school policy and ensures that an adequate and dependable source of revenue creates a framework for educational opportunity for all students.

2. The community, through the district school board, provides and maintains appropriate middle level programs, personnel, professional development, facilities, equipment, technological support, materials and supplies for student learning.

3. There is ongoing planning by the school and the school district to address future programs, staffing, facility and technological needs as well as capital improvements.

4. Faculty and building administrators have active involvement in the budgetary process including its development and implementation.

5. There are meaningful opportunities for parental involvement in the student's academic achievement and social growth as well as decision-making at the school.

6. The school seeks strong community relationships through productive partnerships with businesses, higher education and community groups and provides opportunities for mutual interaction between the students and the community.

7. The school site, plant and equipment support and enhance all aspects of the middle level educational program and support services for student learning.

8. There is a planned and adequately funded program of building and site management that ensures the maintenance and cleanliness of facilities and equipment as well as the health and safety of all who use the facility.

9. The physical plant and facilities meet all applicable federal and state laws and are in compliance with local fire, health and safety regulations.

10. If food services are provided, the area, menus and equipment ensure that the well being of the students is a priority and is in compliance with state and federal regulations.

11. If transportation is provided appropriate procedures are in place to ensure the safety of the students.

New England Association of Schools and Colleges

Commission on Public Secondary Schools

Report of the Visiting Committee for Timberlane Regional High School

Plaistow, New Hampshire
May 4 - 7, 2008

Richard M. Kraemer, Chair
Colleen Meaney, Assistant Chair
Donald H. Woodworth, Principal

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STATEMENT ON LIMITATIONS

The Distribution, Use and Scope of the Visiting Committee Report

The Commission on Public Secondary Schools of the New England Association of Schools and Colleges located in Bedford, Massachusetts considers this visiting committee report of Timberlane Regional High School to be a privileged document submitted by the Commission on Public Secondary Schools of the New England Association of Schools and Colleges to the principal of the school and by the principal to the state department of education. Distribution of the report within the school community is the responsibility of the school principal. The final visiting committee report must be released in its entirety within sixty days (60) of its completion to the superintendent, school board, public library or town office, and the appropriate news media.

The prime concern of the visiting committee has been to assess the quality of the educational program at Timberlane Regional High School in terms of the Commission's Standards for Accreditation. Neither the total report nor any of its subsections is to be considered an evaluation of any individual staff member but rather a professional appraisal of the school as it appeared to the visiting team.

INTRODUCTION

The New England Association of Schools and Colleges (NEASC) is the oldest of the six regional accrediting agencies in the United States. Since its inception in 1885, the Association has awarded membership and accreditation to those educational institutions in the six-state New England region who seek voluntary affiliation.

The governing body of the Association is its Board of Trustees which supervises the work of six Commissions: the Commission on Institutions of Higher Education (CIHE), the Commission on Independent Schools (CIS), the Commission on Public Secondary Schools (CPSS), the Commission on Technical and Career Institutions (CTCI), the Commission on Public Elementary and Middle Schools (CPEMS), and the Commission on American and International Schools Abroad (CAISA).

As the responsible agency for matters of the evaluation and accreditation of public secondary school member institutions, CPSS requires visiting committees to assess the degree to which the evaluated schools meet the qualitative Standards for Accreditation of the Commission. Those Standards are:

- Teaching and Learning Standards
  - Mission and Expectations for Student Learning
  - Curriculum
  - Instruction
  - Assessment of Student Learning

- Support Teaching and Learning Standards
  - Leadership and Organization

School Resources for Learning
Community Resources for Learning

The accreditation program for public schools involves a threefold process: the self-study conducted by the local professional staff, the on-site evaluation conducted by the Commission's visiting committee, and the follow-up program carried out by the school to implement the findings of its own self-study and the valid recommendations of the visiting committee and those identified by the Commission in the Follow-Up process. Continued accreditation requires that the school be reevaluated at least once every ten years and that it shows continued progress addressing identified needs.

Preparation for the Evaluation Visit - The School Self-Study

A steering committee of the professional staff was appointed to supervise the myriad details inherent in the school's self-study. At Timberlane Regional High School, a committee of 7 members, including the principal, supervised all aspects of the self-study. The steering committee assigned all teachers and administrators in the school to appropriate subcommittees to determine the quality of all programs, activities and facilities available for young people. In addition to faculty members, the self-study committees included parents and students.

The self-study of Timberlane Regional High School extended over a period of 18 school months from September 2006 to January 2008. The visiting committee was pleased to note that students and parents joined the professional staff in the self-study deliberations.

Public schools evaluated by the Commission on Public Secondary Schools must complete appropriate materials to assess their adherence to the Standards for Accreditation and the quality of their educational offerings in light of the school's mission, learning expectations, and unique student population. In addition to using the Self-Study Guides developed by a representative group of New England educators and approved by the Commission, Timberlane Regional High School also used questionnaires developed by The Global Institute at Endicott College to reflect the concepts contained in the Standards for Accreditation. These materials provided discussion items for a comprehensive assessment of the school by the professional staff during the self-study.

It is important that the reader understand that every subcommittee appointed by the steering committee was required to present its report to the entire professional staff for approval. No single report developed in the self-study became part of the official self-study documents until it had been approved by the entire professional staff.

The Process Used by the Visiting Committee

A visiting committee of 17 evaluators was assigned by the Commission on Public Secondary Schools to evaluate the Timberlane Regional High School. The Committee members spent four days in Plaistow, New Hampshire, reviewed the self-study documents which had been prepared for their examination, met with administrators, teachers, other school and system personnel, students and parents, shadowed students, visited classes, and interviewed teachers to determine the degree to which the school meets the Commission's Standards for Accreditation. Since the evaluators represented public schools and, central office administrators diverse points of view were brought to bear on the evaluation of Timberlane Regional High School.
The visiting team built its professional judgment on evidence collected from the

following sources:

- review of the school's self-study materials
- 34 hours shadowing 17 students for a half day
- a total of 24 hours of classroom observation (in addition to time shadowing students)
- numerous informal observations in and around the school
- tours of the facility
- individual meetings with 32 teachers about their work, instructional approaches, and the assessment of student learning
- group meetings with students, parents, school and district administrators, and teachers
- the examination of student work including a selection of work collected by the school

Each conclusion on the report was agreed to by team consensus. Sources of evidence for each conclusion drawn by the visiting committee appear in parenthesis in the Standards sections of the report. The seven Standards for Accreditation reports include commendations and recommendations that in the team's judgment will be helpful to the school as it works to improve teaching and learning and to better meet Commission Standards.

This report of the findings of the visiting committee will be forwarded to the Commission on Public Secondary Schools which will make a decision on the accreditation of Timberlane Regional High School.

Overview of Findings

Although the conclusions of the visiting committee on the school's adherence to the Commission's Standards for Accreditation appear in various sections of this report, the committee wishes to highlight some findings in the paragraphs that follow. These findings are not intended to be a summary of the report.

Teaching and Learning at Timberlane Regional High

It was with evident pride that the school displayed in every classroom and every corridor its mission and expectations for learning. These displays where second only to the wide-spread celebration of student work, especially the product of the outstanding art classes. The mission and expectations for student learning have driven some of the current work on the curriculum and it is showing some signs of being acculturated into the thinking and actions of the school. When the established expectations for learning are imbedded in the school community's thinking the rubrics that have been developed to measure the success of the expectations' implementation will find their way into the classroom. The rubrics have yet to take on a significant focus in the school's culture. The faculty must finish this task and implement the results as soon as possible. As the mission is revised and reviewed during the next five years, special attention must now be paid to the involvement of parents and students in the process.

Curriculum has been developed for the core areas, but these will need to be revisited to ensure that the expectations for student learning are embedded in them. It is noteworthy that so many curriculum documents have been developed and that there is new thinking on the development of new electives that will incorporate contemporary fields of student interest.

A few rubrics have been developed to measure the implementation of the expectations for learning, especially for the assessment of writing skills. Many teachers are proficient with the rubric implementation while other teachers are uncomfortable with their daily use in the classrooms. This is also true of the variety of assessments employed by the classroom teachers. There have been many efforts to implement portfolios and other creative assessments, but the predominant assessment tool continues be best categorized as 'paper and pencil'. The school has committed itself to analyzing the data generated by the students taking their external examinations. The strong staff development devoted to the development of curriculum has benefited the school. As the school moves forward in implementing its mission, similar efforts will be needed to develop a database of assessment results that are specific to the school's expectations for learning to inform efforts to improve both curriculum and instruction. It may be necessary to provide professional development in variety of assessment and in curriculum development and use.

Support of Teaching and Learning at Timberlane Regional High

The administration and teacher leaders are actively engaged in working collaboratively and in a common pursuit of improving their school while also engaging in appropriate celebration of the accomplishments that are found within the school. All constituent groups expressed their satisfaction with current leadership and endorsed the belief that the views expressed by both the appointed and informal leaders represent the best thinking within the school. The challenge to leadership will be to develop a consensus on ways to better utilize time to effectively support student learning and to develop a school-wide system that ensures that each student is known well by an adult in the school.

Although the community has struggled with financing its schools, its members have articulated as well as demonstrated in numerous ways their commitment to their children and to the school system that educates their children when they have found the issue to be of importance. They have successfully maintained their existing facility and provided resources that have been appropriately utilized within the school, yet they have not responded to some pressing issues such as the need for additional rooms and flexible spaces. The children have benefited from the support they receive through the library, special services, the guidance department and the nurse. All of the professionals found in these groups are working diligently to appropriately utilize available resources to benefit all children. The children have also received continuous support through the superintendent and his office. All are currently being confronted with a need to prepare for an eventual increase in student enrollment which will challenge the present facility's capacity and the need to design the new areas with the same intentionality as was used in the design of the Performing Arts Center. There are design aspects of the existing building that require rethinking and redesigning as well as projected needs that will be best met through an expansion of the present facility. The community has shown its ability to support the best in the status quo; it will soon be called upon to create something new that is worthy of its ideals and its care for its young people.

School & Community Profile Report

I. The Community

Timberlane Regional High School is located in Plaistow, New Hampshire, and serves the communities of Atkinson, Danville, Plaistow, and Sandown. Situated in southern New Hampshire just north of the Massachusetts border and the Merrimack River, Timberlane is approximately 25 miles inland from the Atlantic Ocean and almost equidistant from Portsmouth, NH, (33.5 miles), Manchester, NH, (36 miles), and Boston, MA, (39 miles). The high school is located in a residential wooded area, while the entire district ranges in character from rural to suburban. The nearest city with a population over fifty thousand is Haverhill, MA, adjacent to Plaistow, four miles from the school. With proximity to Route 495 in Massachusetts, district commuters have reasonable access to major highways (I-95 and I-93) and commercial centers in Massachusetts and New Hampshire.

In a fifteen-year period the population of the Timberlane Regional School District increased over 28% (from 19,098 in 1990 to 24,501 in 2005) with the greatest increases taking place in Danville and Sandown. 2005 figures indicate 6,613 residents of Atkinson, 4,394 residents of Danville, 7,769 residents of Plaistow, and 5,725 residents of Sandown. The District's ethnic make-up is over 99% Caucasian with 0.5% Asian. The median income for households in the District is just over $65,000, with Atkinson at the high end ($69,729) and Danville at the low end ($57,287). The District is mainly residential; there are no major industries in any of the four towns. Atkinson and Plaistow have retail and sales centers, whereas Sandown and Danville only have small town stores. Plaistow's largest employer is the School District with 455 employees, followed by Market Basket (225); Wal-Mart (222); and Shaw's Supermarket (160). Atkinson's largest employer is Lewis Builders with 88 employees. Neither Sandown nor Danville has firms that employ more than forty people. As in other communities along the Massachusetts border in southern New Hampshire, the District has seen a dramatic rise in the cost of housing over the past decade. The unemployment rate in the District ranges from a high of 4.5% in Plaistow to a low of 3.4% in Danville. The percentage of families living below the poverty line ranges from 3.3% in both Atkinson and Sandown to 2.1% in Plaistow.

In addition to the high school, there are five elementary schools and one middle school in the District, for a total student population of 4,463 during the 2006-2007 school year. There are no non-public schools in the District other than private kindergartens. The District is offering public kindergarten for the first time during the 2007-2008 school year. The percentage of local property taxes allocated to the District's schools was 57.9% for the 2005-2006 school year. The average expenditure per pupil, including State aid, for the 2005-2006 school year in the state of New Hampshire was $8,982.24; for that same period the District expended $8,635.72 per pupil. School choice is not an option in the State of New Hampshire.

II. The School and Students

Timberlane Regional High School enrolled 1,613 students in grades 9 through 12 as of October 1, 2006. Twenty-two students (1.4% of the study body) were non-residents of the District. The ethnic/racial/cultural composition of the student body has remained consistently around 99% Caucasian throughout the high school's forty years of operation. Three of the largest classes in the school's history are currently enrolled, due to a steady rise in the student population over the past decade. At the present time, student population projections indicate a leveling-off of this increase over the next few years.

Timberlane Regional High School employed 106 full time regular education and special education teachers in 2006-2007. The daily teacher attendance rate for the previous two years averaged 94.85%. The average teacher/student ratio is 1/14 for all teachers and 1/17 for regular education teachers with an average class size of 21 students. The average number of students assigned to a regular education teacher in academic classes over the course of a semester is 105.

Timberlane has an eight-period day with forty-seven minutes per period. Six twenty-two minute lunch periods are spread over four class periods. There are two homogeneous levels of core course groupings: Accelerated (ACC) and College and Career Prep (CCP). In addition to these basic groupings, students are heterogeneously grouped in most elective courses as well as in the team-taught World Studies (sophomore) and American Studies (junior) courses. Within the eight-period day, there are presently only a few instances of common planning time for such courses. Teachers meet by course in small learning communities once or twice a month during professional development time.

The District's five elementary schools and the middle school feed students into the high school. Average daily student attendance rate in 2004-2005 at the high school was 92.7%. The student dropout rate declined from 5.1% in 2000-2001 to 1.9% in 2004-2005. The evening division diploma program contributed to this decline in the dropout rate.

Several academic awards ceremonies are held toward the end of each school year. These include: separate honors recognition ceremonies for freshmen-sophomores and juniors-seniors, an honor societies cording ceremony, a senior awards ceremony, and a scholarship awards evening for seniors. Athletic teams and the Music Department hold their own awards ceremonies. Faculty members nominate candidates for Student of the Quarter over the course of the school year with 312 students honored. Two juniors are honored annually with the Boys and Girls' State Award, and one sophomore is honored with Hugh O'Brien Leadership Award.

The May 2006 summary report from the State of New Hampshire of state testing results shows that Timberlane sophomores scored below state averages in reading and slightly above state averages in mathematics. (State average reading scores of advanced or proficient stand at 49% compared to the Timberlane 40%, and state average mathematics scores of advanced or proficient are at 41% compared to the Timberlane 42%.) The last two years of SAT scores (Class of 2005 and Class of 2006) show Timberlane students averaging half a point ahead of other public schools in New

Hampshire in math (516.5 to 516) but two and a half points behind the national average in math (516.5 to 519). Timberlane students for this two-year period averaged four points behind the other public schools in New Hampshire in verbal ability (506 to 510) but two points ahead of the national average in verbal ability (506 to 504). (*In regard to SAT verbal scores, the separate 2006 critical reading and writing scores were combined for this comparison*.) In the 2005-2006 school year 82 students sat for 121 AP Exams, and 51% scored 3 or better. Beyond performance on standardized tests, Timberlane students excel in competitive academic programs such as Robotics, Model UN, Math Team, and All State and All New England Music Festivals. Presently, there are no performance graduation requirements beyond Carnegie units and required courses.

38% of all students enrolled in required courses are in Accelerated classes, and 11.7 % of all juniors and seniors are enrolled in AP courses during the 2006-2007 school year. 16% of all students receive Special Education services. For the graduating class of 2006, 39% enrolled in four-year colleges, 24% enrolled in two-year colleges, 4% enrolled in service training programs, 2 % joined the military, and 31% went directly into the work force. The top three school choices of 2006 graduating seniors also happened to be the three closest public colleges: Northern Essex Community College in nearby Haverhill, Massachusetts, the University of New Hampshire, and the New Hampshire Community Technical College System.

Beginning in the 2003-2004 school year, Timberlane has undertaken several initiatives reflecting our Mission Statement's focus on student growth, continuous improvement, and standards. In this period, we have made steady progress to establish a standards-based curriculum with common assessments and to implement a common writing rubric (*6+1*) across the curriculum. Each of these initiatives has been supported by professional development opportunities during which teachers have worked in small Professional Learning Communities (PLCs) to achieve the goals of the initiatives. Formal and informal discussions also took place during this time concerning the advantages and disadvantages of moving away from our current eight period days to some form of block scheduling. For the 2007-2008 school year, a small number of courses will be offered in longer blocks of time. With a focus on growth and continuous improvement, Opportunity Academy was created in the 2003-2004 school year to help the transition of low achieving, incoming freshmen. In the 2007-2008 school year, two teams of core subject area teachers will share common freshmen students to help them to become more successful in their first year in the high school. A Credit Recovery program was initiated in the second semester of 2006-2007 to deal with freshman who had failed their first semester in introductory Math or English courses. In 2007-2008 NovaNet an internet credit recovery program has been implemented as the school's main academic recovery program. This after-school program afforded students the opportunity to continue in a full year course, while re-focusing on those skills and concepts they failed to learn adequately in the first semester, allowing them to gain full credit for the course. A Math Connections program was also put into place to address the needs of students struggling in traditional math courses as they entered the high school. Project Running Start offers students a chance to gain dual high school and college credit in a few selected classes, and Project Lead the Way offers a pre-engineering course of studies for highly interested students. Attendance contracts offer students a second chance, through greatly improved attendance, to gain credit where their record of poor attendance resulted in loss of credit in a course or courses where they received a passing grade. In a three year implementation process, teachers have been asked to use the Blackboard Configuration (BBC) as a daily lesson planning technique to ensure adherence to their departments' standards based curriculum and to reflect teaching strategies that address their students' various learning styles.

Many local business and civic organizations are generous in their support of our senior scholarship program, and a wide range of area employers support our student-employee internship program. Raytheon Corporation has been a major funding source for the school's U.S. FIRST Robotics team with additional support from Analog Devices and Ward Fabrication of Plaistow. In addition to the dual-credit Project Running Start classes, the New Hampshire Community Technical College System offers on-site certification courses for our staff's paraprofessionals. The University of New Hampshire, Keene State, Plymouth State and Rivier College have regularly provided Timberlane with teaching and administrative interns, including a UNH mechanical engineering graduate student for the 2006-2007 school year through project PROBE (Partnership for Research Opportunities to Benefit Education). Funding for Project Lead the Way and PROBE has come primarily through grants from the Walker Fund and the National Science Foundation. Partners for Advancing Learning in Science (PALS), funded by a grant from the New Hampshire Department of Education, provides opportunities for our science teachers to train and collaborate in study groups on matters related to science curriculum with colleagues from three other regional public high schools. The New Hampshire Department of Education also has established a Future Educators Academy career preparation program in many parts of the state, and Timberlane has participated from the start, winning substantial scholarships for individual students in each of its membership years. Members of the Social Studies department have benefited greatly over the past three years from educational training and experiences provided through a $587,000 Teaching United States History grant provided by the U.S. Department of Education.

District Mission Statement

The mission of the Timberlane Regional School District is to educate all students by providing challenging opportunities that emphasize high standards and continuous improvement; and to prepare them to be responsible, self-sufficient, and contributing local, national, and worldwide citizens.

TRHS Mission Statement

The Timberlane Regional High School community values and nurtures the academic, personal, creative, and social growth of all students.

We uphold rigorous academic standards and promote continuous improvement through curriculum and experiences that foster excellence, cooperation, and responsibility.

Academic Expectations

Timberlane students will:

1. Write effectively.
2. Use problem-solving strategies effectively.
3. Research and gather information effectively.

Social and Civic Expectations

Timberlane students will:

1. Offer their best effort and be involved, contributing citizens at school and in the wider community.
2. Work cooperatively and resolve conflicts peacefully.
3. Live responsibly and lend a helping hand to those in need.
4. Speak and act respectfully toward all.

Approved by Faculty November 27, 2006

Approved by School Board February 1, 2007

COMMISSION ON PUBLIC SECONDARY SCHOOLS

TEACHING AND LEARNING STANDARDS

MISSION AND EXPECTATIONS FOR STUDENT LEARNING
CURRICULUM
INSTRUCTION
ASSESSMENT OF STUDENT LEARNING

1 Mission and Expectations for Student Learning

The school's mission statement describes the essence of what the school as a community of learners is seeking to achieve. The expectations for student learning are based on and drawn from the school's mission statement. These expectations are the fundamental goals by which the school continually assesses the effectiveness of the teaching and learning process. Every component of the school community must focus on enabling all students to achieve the school's expectations for student learning.

1. The mission statement and expectations for student learning shall be developed by the school community and approved and supported by the professional staff, the school board, and any other school-wide governing organization.

2. The school's mission statement shall represent the school community's fundamental values and beliefs about student learning.

3. The school shall define school-wide academic, civic, and social learning expectations that:

   - are measurable;
   - reflect the school's mission.

4. For each academic expectation in the mission the school shall have a targeted level of successful achievement identified in a rubric.

5. The school shall have indicators by which it assesses the school's progress in achieving school-wide civic and social expectations.

6. The mission statement and the school's expectations for student learning shall guide the procedures, policies, and decisions of the school and shall be evident in the culture of the school.

7. The school shall review regularly the mission statement and expectations for student learning using a variety of data to ensure that they reflect student needs, community expectations, the district mission, and state and national standards.

Mission and Expectations for Learning

Conclusions:

The Timberlane Regional High School (TRHS) Mission Statement & Expectations for Student Learning at were developed by the school community and approved and supported by the professional staff, the school board, and by the student leadership group. This process took place over a sixteen month period starting in the 2005-2006 academic year. Input from the Executive Committee of the Parent Teacher Student Association (PTSA), the faculty, and the student leadership group was incorporated into the developing mission statement. Wider parental feedback was solicited via a mass mailing to the homes of all students. At the beginning of the 2006-2007 academic year the new mission statement and academic, social and civic expectations were shared with the student body. Final adoption of the revised mission statement and academic, social and civic expectations took place at a series of meetings in the middle of the 2006-2007 school year. The high school faculty approved the document on November 27, 2006. The school faculty and TRHS Student Voice, a representative body of the various student organizations, approved the mission and expectations. The final approval step took place when the school board approved the mission statement and expectations for student learning at a meeting in February 2007. At the time of the accreditation team's visit, the Mission and Expectations for Student Learning had been in place for fourteen months, providing some time for it to become a guiding force in the school community, although, in fact, work must be done for this to take place. (Self-study, Panel presentation, Meetings with teachers, Endicott Survey)

Timberlane Regional High School's Mission Statement represents the school community's fundamental values and beliefs about student learning; but, the school is in the very beginning stages of assessing its attainment of the expressed goals and the effectiveness of teaching and learning at the high school. There is general agreement among all Timberlane constituents that the "6+1" writing rubric is the most highly developed and widely implemented measure with which the 'effective writing' expectation can be measured. Despite the considerable time and effort devoted to the development of the 6+1 writing rubric, it is not yet fully implemented across the curriculum, however. While performance rubrics are used in other academic areas, their use is not consistent in the various departments or with every teacher at Timberlane Regional High School. Performance rubrics to measure the personal, creative, civic and social growth of all students identified in the mission statement have yet to be developed and implemented. As a result, the operational organization of the widely held beliefs expressed in the mission statement remains incomplete. The resulting impact is twofold: Timberlane has not yet reached the point where it is a fully mission-driven school and the faculty is challenged by the work ahead of them to become fully mission-driven. (Classroom observations, Self-study, Shadowing, Meetings with teachers, Meetings with students, Endicott Survey)

Timberlane Regional High School teachers have thoroughly defined a measurable academic writing expectation. Both the 6+1 writing rubric and the writing traits scoring rubrics are comprehensive and clear for both teachers and students. While the 6+1 writing rubric is not yet used in a predictable or similar fashion by each Timberlane teacher in every department once every semester, the effective writing expectation and its accompanying measure are close to full implementation. That said, the quantity and quality of written work required of students in the College Career Prep (CCP) level of the curriculum do not meet the expectation of rigor expressed in the mission statement. The problem-solving and research expectations are in the early stages of definition. The performance rubrics to measure attainment of these two academic expectations currently exist in draft form and appear well on their way to completion. The TRHS civic and social learning expectations expressed in the OWLS motto have been clearly stated but rubrics have not yet been developed. Without defined rubrics, the faculty and students have been unable to measure appropriate performance by which the school can judge a student's achievement of his/her goals. As a result of the substantial focus on the effective writing expectation and performance measures, progress on the other academic, social and civic expectations has been slow. Teachers and students are far less aware of these other expectations, and many students are actually unaware of their existence. (Classroom observations, Self-study, Shadowing, Student work, Teachers, Meetings with teachers, Meetings with students, Meetings with parents, Meetings with school leadership team)

At this time, the Timberlane faculty has not identified a targeted level of successful achievement in a rubric for each of the academic expectations. While the school's 6+1 writing rubric and the draft rubrics for problem-solving and research show a clear continuum of student skills in those academic areas, a particular level of performance has been identified as the minimum level of success for all students. Documents supporting the 6+1 writing materials state: "we would expect that our students will demonstrate greater strengths in some areas rather than others. The scoring and reporting provides students with formative feedback of their writing strengths and weaknesses in a variety of different areas. It should be noted that some courses will be scored only in areas aligned with their subject's attributes." Consequently, interdepartmental collaboration is necessary for the faculty to have a targeted level of achievement identified within the rubric for writing. This is also necessary for the problem-solving and research expectations. This, in fact, is not supportive of the need for curriculum integration. (Classroom observations, Meetings with teachers, Meetings with department leaders)

TRHS does not yet have indicators by which it assesses the school's progress in achieving school-wide civic and social expectations. While a small number of students are aware of the school-wide civic and social expectations, evidence suggests that there is not wide-spread understanding of the expectations. TRHS has been developing school-wide rubrics for its academic expectations and has yet to develop indicators and evaluation tools for its civic and social expectations. According to the surveys, fewer than half of the teachers were aware of the work done on social and civic expectations. While the self-study reports that "The agenda book annually given to each student provides the standards by which all actions are measured", the student survey data shows that only 25% of the students says they respect each other and only 31.5% of the students reports that students respect teachers. This result indicates that a small minority of the students fully understands the civic expectation of speaking and acting respectfully toward all. Furthermore, only 30% of the students report "knowing the goals my school is working on this year". As a result, there is no method at present of assessing the progress in achieving school-wide civic and social expectations. (Self-study, Shadowing, Meetings with students, Endicott Survey)

The mission statement and expectations for student learning do not currently guide the procedures, policies, and decisions of the school and are not universally evident in the culture of the school. TRHS has begun to use its expectations for student learning to direct the teaching of writing, but has yet to fully implement the expectations related to problem-solving and research. The academic expectations for student learning are prominently displayed throughout the school in its classrooms, offices and hallways. However, only a small number of students appear to understand and have internalized those expectations. The 6+1 writing rubric is being used by many faculty members and students are well acquainted with the program. The teaching of effective problem-solving strategies varies from class to class and subject to subject. The fact that rubrics for problem-solving and research exist only in draft form prevents them from being used at this time to guide procedures, policies and decisions of the school. Surveys indicate that less than 60% of the staff feels that the school lives its mission statement or considers it when making important decisions. Significant work needs to be done to insure that all stakeholders understand and implement the mission. (Self-study, Teachers, Meetings with teachers, Meetings with parents, Survey)

Over the past three years, TRHS has revised its mission statement and expectations for student learning. Following the first revision of this document, it was presented to faculty, parents, students and the superintendent. It was approved by the school committee and has been in place for approximately 14 months. Since the adoption by the school committee, this document has not been reviewed. A number of students and parents state that they are unaware of the mission. Many teachers acknowledged not considering the mission in important decisions, thus, there is a need for a discussion about the importance of the mission and expectations. Regularly planned review of the mission by a committee representing all stakeholders is necessary to assure the continued relevance and strength of the mission. (Self-study, Panel presentation, Meetings with teachers, Meetings with parents, Meetings with department leaders, Meetings with school leadership team,)

Commendations

1. The concise and clearly written Mission Statement and Expectations for Student Learning
2. Adoption of the 6+1 writing rubric and writing traits scoring rubric
3. Use of the 6+1 rubric across the curriculum to improve writing

Recommendations

1. Create the conditions for greater school and community awareness of the mission and expectations
2. Clearly define each of the academic, civic and social learning expectations
3. Create performance measures for each of the civic and social learning expectations
4. For each of the three academic expectations, clearly articulate the targeted level of successful achievement identified in the rubric
5. Develop and implement a set of indicators by which the school will assess their progress in achieving school-wide civic and social expectations
6. Establish a process by which the mission statement and expectations for student learning guide the creation of procedures, policies, and decisions of the school
7. Regular review of the mission and expectations is necessary to insure its viability and relevance

2 CURRICULUM

The curriculum, which includes coursework, co-curricular activities, and other school-approved educational experiences, is the school's formal plan to fulfill its mission statement and expectations for student learning. The curriculum links the school's beliefs, its expectations for student learning, and its instructional practices. The strength of that link is dependent upon the professional staff's commitment to and involvement in a comprehensive, ongoing review of the curriculum.

1. Each curriculum area shall identify those school-wide academic expectations for which it is responsible.

2. The curriculum shall be aligned with the school-wide academic expectations and shall ensure that all students have sufficient opportunity to practice and achieve each of those expectations.

3. The written curriculum shall:

    - prescribe content;
    - integrate relevant school-wide learning expectations;
    - identify course-specific learning goals;
    - suggest instructional strategies;
    - suggest assessment techniques including the use of school-wide rubrics.

4. The curriculum shall engage all students in inquiry, problem-solving, and higher order thinking as well as provide opportunities for the authentic application of knowledge and skills.

5. The curriculum shall:

    - be appropriately integrated;
    - emphasize depth of understanding over breadth of coverage.

6. The school shall provide opportunities for all students to extend learning beyond the normal course offerings and the school campus.

7. There shall be effective curricular coordination and articulation between and among all academic areas within the school as well as with sending schools in the district.

8. Instructional materials, technology, equipment, supplies, facilities, staffing levels, and the resources of the library/media center shall be sufficient to allow for the implementation of the curriculum.

9. The professional staff shall be actively involved in the ongoing development, evaluation, and revision of the curriculum based on assessments of student performance in achieving the school's academic expectations and course-specific learning goals.

10. The school shall commit sufficient time, financial resources, and personnel to the development, evaluation, and revision of curriculum.

11. Professional development activities shall support the development and implementation of the curriculum.

Curriculum

Conclusions

TRHS specifies three school-wide academic expectations for which departments of Art, English, Health & Physical Education, Mathematics, Music, Theater, Science, Social Studies, Special Education, Technology, and World Language assume responsibility. All curriculum areas (save World Languages) support the academic expectation to write effectively as assessed by the school-wide adoption of the 6+1 Rubric and they share joint responsibility for its consistent use at least two times per marking quarter. The World Language department is developing an appropriate set of rubrics for students writing in a language other than English. The remaining two academic expectations for problem-solving and researching and gathering information have not been similarly supported as school-wide rubrics are in development for those expectations. Because the agreed-upon use of twice per quarter is not consistently implemented, the academic expectations are not yet a driving force in the development and implementation of curriculum at TRHS, nor is there a clear plan outlining how all curriculum areas will work together to deliver these academic expectations to all students. It is necessary to include the expectations in all curriculum delivery and the rubrics in frequent assessment to make them part of teacher student relationships in the classroom. (Self-study, Meetings with teachers, Meetings with School Board)

Most of the curricula at TRHS have been developed within the last three years, and they indicate the school-wide academic expectations for writing that each course is responsible for teaching. In addition, completed curricula have been aligned with the New Hampshire State Standards, and they list core competencies which students must practice and demonstrate in order to show mastery of the objectives for the course. Currently, all of the core area curricula have been completed; however, the curricula for elective courses, Evening and Summer School divisions still need to be completed. Because curricula at TRHS are connected to the school-wide expectation for writing, as written in the curriculum, students have many opportunities to practice and achieve this expectation through a variety of curricular offerings and through prescribed graduation requirements. Moreover, the school-wide use of the 6+1 rubric gives students many opportunities to master the expectation of writing effectively in many different curricular areas. However, opportunities connected to the remaining expectations remain incomplete so that students can not practice and achieve all of the school-wide expectations. (Meetings with teachers, Self Study materials, TRHS Curriculum)

TRHS makes use of a school-wide curriculum template designed to promote consistency across subject areas and endeavors to ensure that all curricula adhere to state standards. The existing written curricula at TRHS include school-wide learning expectations and identify New Hampshire Grade Level Expectations, essential questions, enduring understandings, core course competencies, key terms and vocabulary, and lists of suggested texts and skills. Curricula do not suggest instructional strategies; rather, curriculum guides provide a direction for content and a general timeline for unit completion. Some assessment strategies are included in the curricula, but this is not a common practice and rubrics do not yet exist for assessments; common assessments do exist, but these are few in number and have not been implemented in a substantive manner. All curricular areas do, however, identify the 6+1 Rubric as a consistent assessment measure of the school-wide expectation for writing. As a result, while curricula provide a direction for delivery of instruction, there are inconsistent measures for the ways in which curriculum is assessed. (Self-study, Meetings with teachers, TRHS Curriculum)

The curriculum engages a limited number of students in higher order thinking skills and inquiry-based learning. There are areas of strong teaching with high expectations which include inquiry-based learning and higher order thinking skills taking place in some classes. For the majority of the students in CCP classes, the expectations are too low and not enough is being done to encourage critical thinking. As a result, many of the students who would benefit most from the experience of the higher order thinking skills to be gained through inquiry, problem-solving and other activities are not receiving them. For these students the curriculum largely involves repetitive practice of skills rather than an important emphasis on critical thinking or application. (Classroom observations, Shadowing, Student work, Meetings with teachers)

Few students are being asked to apply what they learn in activities that demand authentic application of their skills. Many examples of inquiry-based learning and problem-solving skills are cited in the curriculum and noted in the self-study, but there are few examples of authentic application of knowledge and skills in the curriculum, in student work, or from information gathered in meetings with teachers. Survey information also indicates that while 85% of teachers believe their students have many opportunities to apply what they are learning, only 52% of parents and 41% of students agree. Thus, many students perceive limited opportunities to engage in the real-life applications of the instruction that is taking place in the classroom. (Self-study material, Student work, Teachers, Meetings with teachers, Survey)

The course offerings at TRHS are extensive and offer a wide variety of choices to the students. The curriculum, however, is largely isolated by subject area. Aside from the American and World Studies classes, there is almost no integration taking place. This is acknowledged in the self-study and in meetings with teachers. Teachers cite lack of time to prepare integrated units and an abundance of other initiatives that have taken precedence over issues like integration. The administration and teachers also cite the unavailability of teachers and room as the reasons for the absence of the third integrated class, "Humanity and the Cosmos", as not being given. There must be an active effort created to encourage integration of subjects while the limitations of resources are addressed. Curricula for academic areas are exact in identifying grade level expectations, essential questions, enduring understandings, core course competencies, key terms, and skills, but they are much less exact in describing the depth of understandings which students should gain as they complete the activities in all academic areas. (Self-study material, Teachers, Meetings with teachers, Meetings with school leadership team)

TRHS has made efforts to provide extended opportunities for students. While some of these are good programs, a few fall short of their intended purpose. The Opportunity Academy is noted in the self-study as an extended learning piece and is designed to capture freshman students who might otherwise fail to find success in school due to reading deficiencies. It is observed that leveled CCP classes lack rigor, which is denying these students the opportunity to engage their minds. There was a recurring theme throughout the visit that there is more tracking of students within the school than is noted in the schedule and in the self-study. Learning opportunities that group students together homogeneously do not provide high expectations for all students and thus, actually inhibit student learning for some. (Classroom observations, Teachers, Meetings with students, Meetings with school leadership team)

There is some curricular coordination and articulation between and among academic areas at TRHS, but these are not consistent. There are two School Improvement Facilitators who are charged with coordinating the development and implementation of curriculum and working with individual departments to ensure that there is coordination within curricular areas. The school's recent work in all curricular areas using the school-wide curriculum template has also improved the articulation within individual subject areas. The TRHS's adoption of the 6+1 Rubric across subject areas has fostered some alignment among various curricular areas as all teachers make use of the rubric and report results on at least two assignments. The use of the 6+1 Rubric has also fostered some articulation with the Timberlane Middle School where the rubric is also used there. There is less curricular coordination among all subject areas, with World Literature and American Studies as the only integrated courses, both combining English with social studies. Other courses integrated with the Art Department have been planned, but to date, none of these have been taught. The Endicott Survey information indicates that students [64%] and parents [45%] see little evidence of interdisciplinary applications in classes. As a result, there are small pockets of coordination among various curricular areas at TRHS, but there are no consistent and systemic measures to provide articulation between academic areas. (Self Study, Interviews with teachers, Endicott Study)

The faculty and staff highly commend the efforts made by the media specialist to open up the media center to students and to provide materials for curricular support. They comment that there has been a tremendous improvement over recent years. The staff also believes that technology and equipment are adequate for the implementation of curriculum this sentiment echoed by the school board and the "My Voice" survey. However, this same survey cites that only 18% of students use the library during class and that even fewer use it outside of class. There is very little seating space in the media center and this is part of the problem. The Center is not large enough to accommodate a full class comfortably and often crowded with students from study halls eager to enjoy the space, further limiting available seating. It should be noted that, while staff members find technology equipment throughout the school to be adequate, some departments do not have as great an access to technology as others. Teachers have also stated that there are challenges in coordinating the sharing of materials and books when there is a single class set and more than one class needs to use them. A complete implementation of the curriculum is restricted by absent technology, insufficient instructional materials, limited supplies, and the inadequacies of the facilities. (Self-study material, Facility tour, Teachers, Meetings with teachers, Meetings with students, Meetings with School Board)

There has been a consistent program of ongoing evaluation and revision of curriculum at TRHS. The creation of the School Improvement Facilitator positions in Humanities and the Science, Math and Technology have been of value in developing new, uniform, school-wide curricula and in assisting teachers with curriculum delivery. School Improvement Facilitators review standardized assessments to determine areas of needed improvement within the curriculum. The professional staff, through departmental PLCs, has recently completed a three-year task of developing/revising all core subject courses to achieve a standards-based curriculum. The District conducts an ongoing review of subject matter within all academic departments, on a five-year cycle performed by the professional staff from each of the district schools. Staff members from the various departments serve as high school representatives on all District Curriculum Area committees. The results of student performance on standardized assessments such as the NHEAIP and NECAP state testing have been analyzed at both the administrative and departmental level to make decisions regarding the evaluation and revision of curriculum. However, teacher and common departmental assessments of student performance on Six Plus One writing assignments (academic expectation #1) have not yet been used to inform ongoing development, evaluation or revision of curriculum. This is true, as well, for the recently introduced school-wide academic expectations related to problem solving and research. In addition to existing structures, a regular process for the review of curriculum based upon assessment of student performance relative to the school-wide academic expectations needs to drive the evaluation and revision of curriculum. (Self Study, Teacher Interview, Meetings with Teachers, Survey, Principal Interview)

TRHS employs two School Improvement Facilitators as curriculum specialists. One of them teaches one class per day while the other is not currently assigned to any classes. One of these individuals reports that this is currently enough time to allow them to accomplish what they need to do. The faculty, however, feels very strongly that there are not enough time and financial resources committed to the curriculum work which must be done by the teachers. The faculty reports that the lead teachers in each department have many demands placed on their time that can not currently be met, including work necessary for curriculum. To accomplish what has been done, tremendous dedication and focus have been dedicated to curriculum work by the entire faculty, and more time and resources need to be allotted to conclude the proper development, evaluation, and revision of curriculum. (Teachers, Meetings with teachers, Meetings with department leaders, Survey)

The Timberlane Regional School District – through its Professional Development Committee – provides many professional development opportunities for teachers, although many have broad application rather than providing specifically for the support and implementation of curriculum. Professional development topics are drawn from a district-wide survey. During the school year, 6 Professional Development Days and 9 Early Dismissal Days are dedicated solely to district and school-based issues. Faculty members report that they would like more professional development time that is directly related to implementing, reviewing and revising the new curricula. Teachers at Timberlane High School have adopted the Professional Learning Communities [PLC] model which focuses more directly on issues pertaining to curriculum. Of the PLC's currently in place, most are oriented toward academic areas and deal exclusively with curriculum. Faculty and administration should provide more opportunities for school and district professional development, particularly pertaining to curriculum development and implementation to facilitate completion of the excellent beginnings and the commendable professionalism of the faculty towards curriculum. (Self study, Meetings with teachers, Teacher interview)

Commendations

1. The development of curricula which are aligned to State Standards and district goals and which make use of core competencies
2. The ongoing cycle of curriculum review and revision
3. The implementation of a comprehensive curriculum format which is used school-wide
4. Efforts made by the media specialist to reach out to her students and staff and improve the atmosphere of the media center
5. The development of Professional Learning Communities

Recommendations

1. Identify the curriculum areas which have responsibility for the academic expectations of problem-solving and researching and gathering information
2. Complete and implement the sequence of curricula for all instructional areas, including elective courses, Evening Division, and Summer School
3. Ensure that regular and extended learning opportunities meet students' needs without compromising curriculum, rigor, or high expectations
4. Design and implement activities that provide authentic application of curricular goals and objectives and develop higher order thinking skills and practices for all students, no matter the course or level
5. Provide time within and across departments for professional development activities that address curriculum review and implementation
6. Ensure that the curriculum template includes instructional activities and assessment strategies, including the use of school-wide rubrics

3 INSTRUCTION

The quality of instruction in a school is the single most important factor affecting the quality of student learning, the achievement of expectations for student learning, the delivery of the curriculum, and the assessment of student progress. Instructional practices must be grounded in the school's mission and expectations for student learning, supported by research in best practice, and refined and improved based on identified student needs. Teachers are expected to be reflective about their instructional strategies and to collaborate with their colleagues about instruction and student learning.

1. Instructional strategies shall be consistent with the school's mission statement and expectations for student learning.

2. Instructional strategies shall:

    - personalize instruction;
    - make connections across disciplines;
    - engage students as active learners;
    - engage students as self-directed learners;
    - involve all students in higher order thinking to promote depth of understanding;
    - provide opportunities for students to apply knowledge or skills;
    - promote student self-assessment and self-reflection.

3. Teachers shall use feedback from a variety of sources including other teachers, students, supervisors, and parents as a means of improving instruction.

4. Teachers shall be expert in their content area, knowledgeable about current research on effective instructional approaches, and reflective about their own practices.

5. Discussion of instructional strategies shall be a significant part of the professional culture of the school.

6. Technology shall be integrated into and supportive of teaching and learning.

7. The school’s professional development program shall be guided by identified instructional needs and shall provide opportunities for teachers to develop and improve their instructional strategies.

8. Teacher supervision and evaluation processes shall be used to improve instruction for the purposes of enhancing student learning and meeting student needs.

Instruction

Conclusions:

Some TRHS teachers employ instructional strategies that align with the school's mission statement and expectations for student learning. However, only 51% of teachers responding to the survey reported that the mission statement influenced their repertoire of teaching methods. Writing across the curriculum is a TRHS whole school priority. Teachers in all disciplines are expected to use the 6+1 rubric to assess student writing at least once per semester and to report the results to administration. According to teachers and students, this is not yet happening consistently. In some classes, problem-solving is an integral part of the instruction. In the Gourmet class, students are given a 'Mystery Basket' of ingredients and must develop recipes and cook a meal using those ingredients. In physics class, students are trying to figure out how to build a race car using a mousetrap for the 'motor.' Students in a math class demonstrated problem-solving skills in a group activity. However, the majority of lessons observed did not reflect widespread development of problem solving and critical thinking skills. Lessons that tapped into higher order thinking skills were observed in some of the AP and accelerated classes, but were rarely seen in the College and Career Prep classes. Student work shows that students are asked to research and gather information in many classes. There should be a close alignment between instructional strategies and the school's expectation that students will effectively write, problem-solve, and gather information. (Classroom observations Self-study Shadowing, Student work, Teachers, Meetings with teachers, Meetings with students)

Some teachers at TRHS employ creative instructional strategies and varied practices in their classrooms. Samples of student work reveal some very creative lessons while others are very traditional. In some classes students demonstrate active learning. In Spanish classes, students were singing their new vocabulary words and in a physics class, students were measuring friction while racing toy cars. In several classes teachers were using video segments from YouTube to spark student interest. A few classes followed the instructional model of teacher as coach, student as worker. In these classes students were self-directed and worked independently to assemble portfolios of their work, and teachers conferred with students about the work. However, observations reveal that there is still an emphasis on teacher-directed lessons in many classrooms. There are passive, seemingly disengaged learners doing such things as wearing iPod/MP3 headphones. This is not consistent with students as active learners. At the same time, teachers at TRHS appear to have a good rapport with their students, and 96% of the teachers feel excited to be working with students. Teachers were observed making personal connections to their students in an attempt to help students connect to the lesson. Students also feel comfortable chatting with teachers, and in fact, in some cases there was an excess of casual conversation to the detriment of the lesson. The Program of Studies offers a wide range of courses available to students, including vocational programs, AP classes and a range of electives. Within some classes, students are allowed to opt for either accelerated or College and Career Preparation credit. Although all teachers at TRHS express a commitment to help all students achieve success, there is little personalization of instruction beyond a choice of questions for an essay or different options for a project. Differentiation of instruction was not observed in the majority of classes.

Teachers at TRHS have tried to make connections across disciplines. Some students take the combined American Literature/American History course, and others are in the World Literature/World Studies program. There have been attempts to develop an interdisciplinary freshman program, but that program is struggling because of a lack of common planning time for the teachers involved. There is also an effort to provide consistency for students as they move through the schedule. The school has adopted the Blackboard Configuration (BBC) model to provide a consistent instructional strategy across the disciplines. The BBC protocol was observed in about 50% of the classes. Some teachers have modified the basic structure to meet the needs of the lesson. Most students expect to find a "Do Now" activity when they arrive for class. The TRHS mission statement refers to "rigorous academic standards" for all students, and there are high expectations and rigor in many accelerated classes and some College & Career Preparation classes, although the expectations for student work and behavior are obviously lower in other classes. Some student work shows high marks for work with errors in grammar, punctuation, and usage. According to parents, and teachers, expectations for student work and behavior vary from teacher to teacher. Effective and varied instructional strategies can lead to depth of understanding, however. In one senior film study class, students develop higher order thinking skills by writing a thesis paper based on their independent analysis of a film. While students are asked to analyze and synthesize in some classes, especially at the accelerated level, other classes do not include or require higher order thinking skills. A math teacher offered the excuse that a lack of preparation at the middle school level prevents the high school teacher from tapping into higher order thinking skills. In a few classes, students have the opportunity to apply their knowledge and skills in real world situations. The theatre department presented the musical My Fair Lady for the middle school. In the Gourmet and Pastry classes, students routinely plan and prepare meals for faculty members. Students in a playwriting class have written plays, the best of which were performed in another theatre arts class. Students in the Math Honor Society tutor other students. TRHS teachers and administrators are in the process of adopting school-wide rubrics. When they are actively implemented, these rubrics can help students critique and assess their own work. Such self-assessment and self-reflection seem to be firmly in place within the music and art departments where students routinely analyze their performance or their work although other departments utilize this to a lesser degree. Overall, improved instructional strategies and consistent adherence to academic expectations are needed to promote higher order thinking skills, raise expectations, and lead to rigor for all students. (Classroom observations Self-study Shadowing, Panel presentation, Student work, Teachers, Meetings with teachers, Meetings with students, Meetings with parents, Survey)

Teachers at TRHS make limited use of feedback as a means of improving instruction. New teachers at TRHS work with a mentor who observes the new teacher and provides written feedback and suggestions regarding instructional strategies. Teachers report this feedback valuable and appreciate the collegial relationship. Administrators have piloted performing informal observations of teaching practices and recently have initiated a "Palm Pilot walk-through observation process" for which .they plan to do at least 10 "walk through" observations per week, recording data from the walk through on the Palm Pilot. Additionally, administrators also perform formal observations of some teachers although many teachers report that they have not been observed for many years, and there is less satisfaction with this evaluation process. In a recent survey fewer than half of the faculty (48%) feels that the evaluation process is effective in improving classroom instruction. Teachers want feedback from evaluators who know the subject area and express regret that the department chairpersons were no longer doing evaluations. When the evaluator was not knowledgeable in the subject area, only 14% of the teachers found the evaluation to be effective. Many students also have the opportunity to offer feedback to teachers using an online form available for this, and many teachers use their own evaluation form at the end of a course. This feedback is then used informally to improve instruction. However, in the student survey only 44.5% of the students report being asked to provide input in order to improve instruction. Fewer than 20% of the parents responding to the survey report being asked to provide input regarding their child's instruction. There must be feedback pertaining to the improvement of instructional strategies in order to strengthen instructional practices, but teachers must avail themselves of the existing feedback. (Self-study Teachers, Meetings with teachers, Meetings with department leaders)

Teachers are expert in their content area, somewhat knowledgeable about current research on effective instructional approaches and frustrated by a lack of time and structure to reflect on their own practices. All teachers are teaching in their own areas of expertise and are highly qualified in their content areas. Teachers remain current in their subject specialty by maintaining subscriptions to professional journals and attending professional development activities when approved by the administration. Some teachers attend summer programs to acquire new instructional strategies. Content area knowledge is driven by course content and the needs of the teacher to adapt to curriculum changes. Seventy-five percent of students report that teachers know the material for their classes, but only forty nine percent of parents feel the same way, and only sixty-seven percent of school board members are satisfied with the qualifications and expertise of teachers. Teachers try to remain current about effective instructional practices through reflecting on their own practices, informal discussions with peers, the evaluation process and the mentoring program; but district-driven professional development does not fully meet the needs of the faculty. Teacher reflection on student assessments conducted within most departments led to review of specific skills and content area knowledge, but teacher reflection on their own practice seems limited in depth. The continuous improvement of pedagogical knowledge of teachers and a structure for reflective practices are needed in order to positively impact student learning. (Classroom observations, Self-study, Facility tour, Meetings with teachers, Meetings with students, Survey)

While teachers are not routinely engaged in formal discussions of instructional practices, they are often engaged in informal conversations. Nearly 91% of teachers discuss instructional strategies with colleagues. Teachers report that some 75% of department and faculty room conversations and a significant number of e-mails revolve around instructional strategies and personalization. A "shoptalk log" was started to track informal discussions within departments; but because teachers found the process frustrating, the log was discontinued. An open, critical friends group, "What Works for Me," meets monthly after school with a small number of participants this process is also informal and voluntary. A book club meets to read books on pedagogy or other titles of interest, but again this is voluntary and limited in scope. Recently, senior students were invited to join in, and the library purchased copies of **A Thousand Splendid Suns**. Unfortunately, there is a lack of common planning time, hindering collaboration for all teachers--especially for the Freshman Academy. A lack of formal, structured discussion concerning instructional strategies has an adverse effect on the engagement of students as active learners who use higher order thinking to promote depth of understanding. (Self-study Meetings with teachers, Meetings with students, Meetings with school leadership team, Survey)

Technology is integrated into and supportive of teaching and learning. Approximately half the teachers use technology as part of their instructional strategy, even though some systems are outdated, and peripherals such as LCD projectors are not widely available. The school district has made an ongoing commitment to new technology with a 5-year replacement and improvement plan. Previously, the pace of acquisition was slow because of the expense. Some teachers feel the need for both more technology and training. Students are required to use technology as a means to apply knowledge in a variety of ways. One student reported that he used technology in most of his classes and the computer lab was used during his science class. Nearly all computer labs are full of students being instructed on computer use. Student learning is positively impacted by the use of technologies. (Classroom observations Self-study Shadowing, Student work, Teachers, Meetings with teachers, Meetings with students, Meeting with School Board)

The school's professional development program is created by school leaders and is not aligned with teachers' perceived instructional needs. According to faculty members, identified instructional needs do not drive the professional development offerings of the district. The faculty believes professional development offered during early release days is driven by the district. Teachers need more professional development offerings concerning technology. The district professional development committee takes a survey of staff members on a yearly basis, to guide the types of offerings--50% of staff members respond and 50% of those attend after school offerings. Staff members reports that only 43% feel professional development in the area of instructional strategies is based on identified needs. Conflicting evidence concerning the driving force for professional development frustrates the faculty and may be reducing the knowledge growth of rich and varied instructional strategies that should be driven by the school's mission. This conflict limits professional development of faculty and therefore the instructional growth of teachers and learning of students. (Self-study Meetings with teachers, Meetings with students, Survey)

At TRHS there is limited use of the supervision and evaluation process to improve instruction. Less than half of the faculty feels that the evaluation process is effective in improving classroom instruction. Evaluations, are limited by teacher contract, are not done on a regular basis, partly because of the number of evaluations each administrator must complete. Recently, administrators have initiated informal walk-through observations using a Palm Pilot checklist to gather data that is to be shared with the staff as a whole. The supervision and evaluation process should be used to open dialogue that will result in improved instructional strategies and possibly, in improved evaluations. (Self-study Meetings with teachers, Meetings with students, Meetings with school leadership team)

Commendations

1. Teachers who use technology in their instruction have dramatically increased the educational opportunities of students
2. Those teachers who have made connections across disciplines
3. Initial attempts to personalize learning for students
4. The evident content expertise of the faculty
5. Initial efforts to promote discussions of instructional strategies

Recommendations

1. Develop a strategy and timeline for the immediate implementation of the school-wide rubrics to ensure that they are universally used in instruction
2. Embed in the regular practices of the school varied and creative assessments to ensure rigor and challenging expectations for all students
3. Implement authentic assessments to promote higher order thinking in all classes
4. Institute a supervision and observation process that includes feedback from a variety of sources which provides direction on how to improve instructional strategies to positively affect the quality of students' learning
5. Provide sufficient time and a structure for teachers to collaborate and reflect on instructional strategies that will improve student learning

4 Assessment of Student Learning

Assessment is an integral part of the teaching and learning process. Its purpose is to inform students regarding their learning progress and teachers regarding ways to adjust the curriculum and instruction to respond effectively to the learning needs of students. Further, it communicates to the school community the progress of students in achieving the school's expectations for student learning and course-specific learning goals. Assessment results must be continually discussed to improve curriculum and instruction.

1. The school shall have a process to assess school-wide and individual student progress in achieving the academic expectations in the mission based on school-wide rubrics.

2. The school's professional staff shall use data to assess the success of the school in achieving its civic and social expectations.

3. For each learning activity teachers shall clarify to students the relevant school-wide academic expectations and course-specific learning goals that will be assessed.

4. Teachers shall base classroom assessment of student learning on school-wide and course-specific rubrics.

5. Teachers shall use varied assessment strategies to determine student knowledge, skills, and competencies and to assess student growth over time.

6. Teachers shall meet collaboratively to discuss and share student work and the results of student assessments for the purposes of revising the curriculum and improving instructional strategies.

7. The school's professional development program shall provide opportunities for teachers to collaborate in developing a broad range of student assessment strategies.

8. The school's professional staff shall communicate:
   - individual student progress in achieving school-wide academic expectations to students and their families;
   - the school's progress achieving all school-wide expectations to the school community.

Assessment

Conclusions:

TRHS does not have a clear process to assess school-wide and individual student progress in achieving the academic expectations. The school's mission and student expectations document has been written over the last few years but received its final approval from the school board fourteen months ago. In order to assess students' achievement in the academic expectation students will "write effectively," the rubric "6+1" was implemented school-wide. The cooperative effort between the middle school and high school to implement the same writing rubric ensures that the students, parents, and faculty members can measure the students' writing development. The next step in the evolution of the use of the "6+1" rubric is to develop a mechanism to allow faculty members and administrators access to a student's history of 6+1 scores, as well as any future school-wide assessments to ensure that the results can be monitored for growth in student learning. In addition, there is some disparity in the application of 6+1 between faculty members and an indication that it is not used on a regular basis to evaluate all writing across the curriculum. Rubrics are being developed for the other two academic expectations dealing with problem- solving and research. The use of 6+1 Rubric is online but there is a clear need for more uniformity in application. The two other rubrics are in their infancy. At this point, there is not a clear way to assess whether or not the school's graduates have reached the academic expectations as outlined in the mission statement nor is there a way to monitor progress and provide feedback to individual students. (Classroom observations, Self-study, Shadowing, Panel presentation, Student work, Teachers, Meetings with teachers)

The administration and faculty do not collect data in order to determine student success in meeting their civic and social expectations. The social climate at TRHS meets the expectations stated in the school's mission statement. The school does collect data in order to present an overview of student achievement at a student-wide awards assembly. The school has many extra-curricular activities which assist students in reaching the school's civic and social expectations, and has in place a full time social worker, and a "peer-to-peer mediation" group that is very successful in resolving student differences peacefully, which is included in TRHS's social and civic expectations. The school plans to move forward in assessing these social and civic expectations using progress reports, 'My voice' surveys, and discipline data. Because there is no formal assessment of the civic and social accomplishments, students are unaware of what they have achieved and the expectations of the social environment in which they live. (Classroom observations, Self-study, Shadowing, Meetings with students)

The TRHS faculty, as a matter of practice, shares with students the learning goals of the class during the introduction of each learning activity, but the school- wide academic expectations have not been part of this presentation. Classroom observations and review of student work show that teachers have stated learning goals and outlined them with activity specific assessments that were given students as part of their learning activity. On occasion teachers have been observed emphasizing school-wide academic expectations in addition to the activity-specific expectations, and the two were tied together. For example, a social studies teacher introducing a research project emphasized to the students that one of the purposes of this project was to teach the students how to research effectively and included a rubric that explained how this was to be done. In most cases however, students are not aware of how classroom activities relate to the academic expectations in the mission statement that they are responsible for achieving. (Classroom observations, Self-study, Shadowing, Student work, Teachers)

TRHS teachers utilize assessment rubrics to evaluate student performance using course-specific rubrics, but there is limited evidence of the use of school-wide rubrics. Many teachers have created rubrics which clearly outline their expectations for student achievement on a given project. There is no common rubric format, however, and many assignments are graded according to rubrics that are not referenced to the school-wide learning expectations. In English classes, the 6+1 Rubric is not used on all writing assignments, but only once a quarter on a targeted writing assignment. Currently, there are no department-specific rubrics, but some departments (specifically social studies) have developed subject-specific rubrics for writing and are in the process of implementing them department-wide. It is clear to students how to meet classroom expectations, but it is not always clear whether they are meeting school-wide expectations. (Classroom observations, Self-study, Shadowing, Student work, Teachers)

The teachers at TRHS use a variety of assessment strategies to determine student knowledge, skills and competency. Teachers use a variety of assessment strategies such as paper and pencil tests, homework assignments, lab reports, computer simulations, posters, research papers, Power Point presentations, projects that may be oral, written, video, or audio. For example, in a physics class, a teacher wrote a computer simulation model for orbiting space stations and asked each student to calculate the velocity necessary to lift their station to a geosynchronous orbit. In a physical science class, students were challenged to design a bottle rocket that remains in the air a maximum amount of time and explain how each part of their design will work to maximize the time in the air. Faculty members use the 6+1 writing rubric for some assignments, as required by the school progress reports, but they use their own writing rubric for most of the writing assignments. There are indications that students in some classes are allowed to improve their work, but this was not a universal practice. Portfolios or work folders are used in many English classes to assist students in tracking their growth over time. Students have varied opportunities to demonstrate their classroom specific skills but do not always get to improve their work and have few opportunities to measure their skills against the school-wide rubric. (Classroom observations, Shadowing, Student work, Teachers, Meetings with teachers)

The faculty sometimes uses the results of different assessment instruments to revise the curriculum in order to improve instruction. There is a lack of scheduled common planning time for teachers to collaborate, but teachers report finding other informal venues to work together. In an anonymous survey, 70% of the faculty members reported that they meet regularly with colleagues and share student work and best practices. The faculty has designed common midterms and finals in some World Language, Math, Social Studies and Science courses. These specific teachers meet both before and after the exams to discuss student achievement and relevancy to the exam itself, as well as to classroom instruction. The self-study reports that they use assessments to drive their teaching and curriculum offerings as when low sophomore test scores on a state-administered exam in Social Studies revealed a need to revise the Economics course and move it to freshman year. Some curriculum decisions are based on student assessment data, improving instruction over the long term. (Self-study, Teachers, Meetings with teachers, Survey)

There are regular professional development days set aside for faculty collaboration in developing student assessment strategies, but this past year these days have been dedicated to preparation for the NEASC visit and to author state-mandated course competencies. TRHS has a professional development coordinator who works on the district development committee to arrange for quality learning opportunities for faculty and staff, but on a current faculty survey, less than 40% of the staff thought that the professional development program provides opportunities to collaborate with other teachers in developing a broad range of student assessment strategies. Even though 6+1 was implemented school-wide with a six-hour training session, only a selected few English teachers were sent to extended 6+1 training and, because of other pressing issues, there was no time allotted for them to train their colleagues. As a result, there is a wide variety of interpretations of the 6+1 rubric from department to department and teacher to teacher. For example, some teachers feel that no sophomore should expect a *"5"* on the "voice" aspect of the 6+1 rubric, while other teachers feel that any student who puts out a maximum effort can receive a *"5."* Without having ongoing professional development time dedicated to training for the use of the 6+1 school-wide rubric and any future school wide rubric, the school cannot accurately assess student achievement. (Classroom observations, Self-study, Teachers, Meetings with teachers, Survey)

The faculty and staff at TRHS use progress report comments to communicate with parents about how students are progressing on the 6+1 writing rubric. Currently, twice a year on progress reports teachers are mandated to include the score earned by that student on the school-wide rubric for writing effectively. The school plans to institute similar rubrics for the two remaining academic expectations. Parents are invited to contact their child's teacher at any point during the year via e-mail if they have any questions about their child's progress. Future plans also include reporting the status of the school's academic achievements on school-wide expectations to the community at large. There is a real need to improve communication to the parents and the community at large concerning the school-wide expectations, as is being done with the 6+1 rubric results. (Self-study, Teachers, Meetings with teachers, Survey)

Commendations

1. The adoption and use of the 6+1 Rubric as an assessment tool
2. The efforts made at the start of each lesson to clarify the learning expectations
3. The initial steps that have been taken to develop a variety of assessment strategies
4. Efforts to engage the faculty in discussion of authentic assessments

Recommendations

1. Ensure that the rubric for all academic expectations are in use in all classrooms
2. Collect data to assess whether or not the students and the school are achieving their social and civic goals
3. Embed school-wide and academic expectations in assessment practices
4. Provide dedicated scheduled time to be trained in approved rubrics
5. Provide dedicated scheduled time for faculty members to work together to settle on uniform ways to apply the contents of all of the academic rubrics
6. Develop and implement a process which uses the school-wide rubrics to assess individual student progress in achieving the academic expectations
7. Communicate individual student progress in achieving the school-wide academic expectations, based on a set of rubrics, to students and their families

SUPPORT STANDARDS

LEADERSHIP AND ORGANIZATION
SCHOOL RESOURCES FOR LEARNING
COMMUNITY RESOURCES FOR LEARNING

SUPPORT STANDARD

5 LEADERSHIP AND ORGANIZATION

The way in which a school organizes learning for students, fosters leadership, and engages its members has a profound effect on teaching and learning. The professional culture of the school must be characterized by thoughtful, reflective, and constructive discourse about decision-making and practices which supports student learning and well-being.

1. The school board and superintendent shall ensure that the principal has sufficient autonomy and decision-making authority to lead the school in achieving the mission and expectations for student learning.

2. The principal shall provide leadership in the school community by creating and maintaining a shared vision, direction, and focus for student learning.

3. Teachers as well as administrators other than the principal shall provide leadership essential to the improvement of the school.

4. The organization of the school and its educational programs shall promote the school's mission and expectations for student learning.

5. Student grouping patterns shall reflect the diversity of the student body, foster heterogeneity, reflect current research and best practices, and support the achievement of the school's mission and expectations for student learning.

6. The schedule shall be driven by the school's mission and expectations for student learning and shall support the effective implementation of the curriculum, instruction, and assessment.

7. Meaningful roles in the decision-making process shall be accorded to students, parents, and all members of the school staff to promote an atmosphere of participation, responsibility, and ownership.

8. Each teacher shall have a student load that enables the teacher to meet the learning needs of individual students.

9. There shall be a formal, ongoing program through which each student has an adult member of the school community in addition to the school guidance counselor who personalizes each student's educational experience, knows the student well, and assists the student in achieving the school-wide expectations for student learning.

10. The professional staff shall collaborate within and across departments in support of learning for all students.

11. All school staff shall be involved in promoting the well-being and learning of students.

12. Student success shall be regularly acknowledged, celebrated, and displayed.

13. The climate of the school shall be safe, positive, respectful, and supportive, resulting in a sense of pride and ownership.

14. The school board shall support the implementation of the school's mission and expectations for student learning.

Leadership and Organization

Conclusions:

The principal has sufficient autonomy and decision-making authority to lead Timberlane Regional High School. The new superintendent has supported the principal's leadership by providing flexibility in the budget formulation process to allow the principal to develop a building budget that is aligned with the goals and mission of TRHS. Furthermore, while school initiatives are developed at the district level with input by the principal, the implementation of those initiatives is in the hands of the principal. The principal has been extended the autonomy to make decisions related to professional development and use of teacher time to work towards these initiatives. The principal has made changes that have an impact on the school community, to include the development of school improvement facilitators, a power walkthrough system to begin to collect instructional data and provide feedback to faculty members and the restructuring of the department head positions. The level of autonomy provided to the principal by the school board and superintendent has supported the principal to lead TRHS through the change process of school reform. (Meeting with school board, meetings with central office administration, meetings with school leadership team)

While the principal has implemented several formats for communication, a variety of stakeholders reports that too often communication has been one-way and not clear. Communication from the principal to the faculty and staff members, parents and students has been an effort to articulate the vision, direction and focus for school reform. However, there remains to be a need to develop consistent avenues of communication that promote meaningful collaboration, clarity in the articulation of the vision, and depth of discussions focused on school initiatives and their impact on student learning. The principal has an established level of trust and respect in the school community. Stakeholders have described their high regard for his long-term investment and strong reputation at TRHS. He has implemented many avenues for parents, students and faculty members to communicate directly with him, including the *Semesterly with coffee and conversation with the principal*, quarterly newsletter, attendance at the PTSA, and a consistent open door policy. While this has been initially productive, survey data indicates that only 40% of the school staff feels they are involved in school-wide decisions. With this, only 43% indicated that staff members communicate effectively in the building. Also, faculty members describe an inconsistent and ineffective model for collaborative discussion within the school and say they are often frustrated by the quality of school-wide communication. Because TRHS is in the midst of comprehensive school reform, it is critical for the principal to establish a communication system that emphasizes clarity of communication, collaboration and meaningful discussions. Direct and timely communication will contribute to a full investment in the decision- making process for all stakeholders which, in turn, will positively impact the quality of the educational experience for students. (Self-study, panel presentation, teacher interviews, meetings with teachers, meetings with department leaders, meetings with central office administration, meetings with school leadership team, meetings with school support staff)

Teachers are provided with opportunities to take an active role at TRHS. The principal’s style has been to provide a structure where faculty members are able to have an appropriate level of autonomy to complete their work. Teachers are involved in the work of the liaison committee and other leadership opportunities within the building. Individual faculty members have been given the opportunity to develop new courses that take advantage of best practice and professional interests, for example, Art and World History and the World Studies courses. There are teachers who provide leadership at the departmental level. There are also two school administrators assigned as School Improvement Facilitators. These positions require them to provide leadership in curriculum, instruction and assessment. To improve effectiveness, however, the school must clarify the roles and responsibilities of both the School Improvement Facilitators and Team Leaders. Currently, these leaders are overburdened with tasks, and their schedules are not structured to ensure success in completing what is expected of them. Clarifying and redefining the roles of team leaders and school improvement facilitators consistent with the needs of the school and the movement towards school reform will promote the effective leadership at many levels that is essential to the successful improvement of the school. (Teacher interviews, meetings with central office administration, meetings with school leadership team)

The Program of Studies and educational programs support the school's mission and expectations for student learning. The school continues to identify structural opportunities to meet the needs of students and to promote a level of personalization that contributes to student achievement. For example, the school focus on the ninth grade class through the Freshman Academies is indicative of a specific solution for problems that require particular interventions. A policy of inclusion allows students with special needs to participate in a variety of general education classes in order to meet graduation requirements. The district continues to develop the Evening Division that is designed to be an extension of the day program. The evening program continues to provide alternative opportunities for students who are unable to access a traditional educational model. A credit recovery program and summer school programs are in place for students to access support throughout the school year. The school implements a specific writing rubric to address the writing expectations of all subject areas in the school, but it must adhere to a timeline for implementing additional school-wide rubrics that support the academic, social and civic expectations. The school leadership team needs to continue to reflect on the programs already in place to determine whether or not they are consistent with the school's mission, and the school must continue exploring other educational programming opportunities to address student learning. For students with special needs, the student's service delivery should drive the student's educational needs, not program availability. Appropriate educational programs that align with the school's mission and academic expectations will enhance the quality of student learning and educational experience. (Teacher interview, meetings with teachers, meetings with department leaders, meetings with central office administration, meetings with school leadership team, meetings with school support staff)

TRHS utilizes a level system to place its students and structure the academic programs. Examination of the existing level of patterns reveals low expectations at the College Career Program (CCP) and lower-level courses. This pattern of low expectations denies opportunity and may inhibit students from achieving the school's mission and expectations for student learning. Elective classes and select core classes are heterogeneously organized, however. There are also over 30 other non-leveled courses offered to students. At this time, there is also inconsistent programming and learning opportunities for students with special needs within the academic program. Curriculum, instruction, and assessment practices do not consistently reflect the individual needs of students with special needs. Observations and teacher interviews suggest that too many students on Individual Education Plans (IEP) are placed in a few co-taught classes. Large class sizes are a result of combining class sections resulting in an inclusion classroom with more students identified with special needs than students without this identification. Individual teachers make an effort to create an environment characterized by warmth but are frustrated by the number of students with special learning needs. Educational opportunities for students with special needs within the evening program have limited access to support. The school continues to explore opportunities to implement courses that do not designate a particular level of study. TRHS needs to engage in an active dialogue as to whether or not current grouping patterns reflect the educational philosophy of the leadership team, faculty and community and whether they are consistent with educational best practices. These conversations should be meaningful, research-based, and serious about articulating the positive effects of non-leveled courses relating to all students in the building. This school's student grouping patterns reveal low expectations particularly within the CCP and lower level courses that result in inequitable opportunity for some of the school's students. (Classroom observations, self-study, student shadowing, teacher interview, meetings with teachers, meetings with students, meetings with school leadership team)

The current master schedule is limited in its support of the school's mission and expectations for student learning. The school has identified the need to implement a block schedule system to address teacher collaboration, flexibility and opportunities for creative programming. The building principal hopes for the implementation of a block schedule program for the 2009 - 2010 school year. The building leaders predict that any block schedule will reduce transition times and school disruptions. Special education and general education staff will then be able to meet regularly meet for common planning time to coordinate the effective implementation of accommodations and modification strategies within the general classrooms. The school community needs to engage in an active conversation about the structure of the block schedule and how it will promote the school's mission and expectations for student learning. Engaging all stakeholders in the discussion of the block schedule will enhance the quality and effectiveness of the schedule's implementation and success. (Self-study, student showing, panel presentation, teacher interviews, meetings with teachers, meetings with department leaders, meetings with school leadership team, meetings with school support staff, Survey)

Stakeholders indicate that they feel their voices have not been heard in the decision-making process on some critical issues. While teachers indicate they are able to provide initial input related to school initiatives, they do not see themselves as an active part of the actual decision-making. According to survey data, nearly half of the parents and students surveyed feel that they are not contributing members in the decision-making process. Promoting partnerships with parents, students, and faculty members in developing school initiatives will promote broader ownership and may produce higher quality decision-making. (Self-study, teacher interviews, meetings with teachers, meetings with students, meetings with department leaders, meetings with Central Office administration, meetings with school leadership team, meetings with school support staff)

A majority of the teaching staff reports that their teaching loads do not enable them to address the needs of students in their class. While teaching loads vary in number, many report their loads are in excess of 100 students each. Students have indicated in survey data that only 46% of the teachers are aware of their learning needs and 61% of the teachers surveyed have reported that they do not have enough time to meet with students individually. School initiatives, particularly the implementation of a block level schedule, will reduce the student to teacher ratio per day allowing for greater amounts of personalization and meeting the individual student learning needs. Reducing teaching loads will support the goals for improving personalization and will improve the quality of instruction. (Classroom observations, teacher interviews, meetings with teachers, meetings with department leaders, meetings with Central Office administrators, meetings with school leadership team)

A majority of students at TRHS states in the survey that there is no adult; beyond a guidance counselor that they can turn to if they have a problem. In addition, only 20% of staff members indicate that they participate in the school's new program for mentoring students. However since the Endicott survey, TRHS has promoted an initiative to improve the quality of personalization in the school environment. Students, teachers and parents report that the school milieu is caring, supportive and safe. In addition, an advisory program for the 9th grade was implemented this year although the program has yet to be evaluated. There currently is a plan in place to extend the program to students in 10th through 11th grades. A formal program designed to personalize the educational experience for each and every student is critical to ensure that each child will have the personal attention that would contribute to achieving the school-wide expectations. (Self-study, panel presentation, teacher interview, meetings with department leaders, meetings with school leadership team, survey)

There is a collegial environment at TRHS that promotes learning for all students; however, there is a lack of time for faculty members to collaborate around student work, to develop and implement best practices, and to work together across disciplines to improve student learning. This, coupled with many concurrent initiatives and intense focus on writing curriculum, has adversely affected the professional environment. While professional time must be allocated to complete necessary work, time for reflection and collaboration focused on student learning must also be provided. A formal, regularly scheduled time specifically designated for faculty collaboration is needed to offer an opportunity to reflect on student learning and means the of finding success for all students. (Self-study, teacher interviews, meetings with teachers, meetings with students, meetings with department leaders, meetings with school leadership team, meetings with school support staff)

The total school community at TRHS promotes the well-being and learning of students. Office personnel, dining hall staff, Student Resource Officer, school nurses and other support staff members are committed in their support of the students. The dining hall staff earns generous praise from students, parents and faculty members for their responsiveness to recommendations and the service and quality of food offered. The commitment to students by all school staff members has a positive impact on student learning and the quality of the educational environment. (Teacher interviews, meetings with teachers, meetings with students, meetings with department leaders, meetings with school leadership team, meetings with school support staff, survey)

Student success at TRHS is regularly acknowledged, celebrated and displayed. Student achievement is recognized in many different ways including the principal's newsletter, student of the month, spirit week, publication of the honor roll and other student achievements, and specific award ceremonies. Moreover, student success is celebrated throughout the school hallways and classrooms. Student recognition contributes strongly to school pride and a positive learning environment. (Classroom observations, student shadowing, facility tours, teacher interviews, meetings with students, meetings with school leadership team)

While a majority of students indicated, in a survey, that respect has been a troubling issue in the school and community, interviews with parents, students and staff members, as well as direct observation indicated quite the opposite conclusion. TRHS continues to celebrate student success as can be seen in the freshman advisory program, open door policies, and diversified school services, in a serious effort to meet the needs of all students. The addition of the School Resource Officer promotes a climate of safety. Continuous focus and improvement in the school climate is necessary to enhance a sense of well-being and positively impact student achievement. (Classroom observations, student shadowing, facility tour, meetings with teachers, meetings with department leaders, meetings with Central office administration, meetings with school leadership team, meetings with school support staff)

The school board supports the school's mission and expectations for student learning as evidenced by their response on the school survey and the actions they have taken on behalf of all students. The school board has supported technology upgrades, programs in the arts, and the expansion of the world language programs. The board has supported the new administration, the restructuring of the leadership team, and the school initiatives that are currently in place. The board's efforts to emphasize its oversight role and its clear intent to avoid micro-managing have supported a more positive working relationship between the school and the board. (Self-study, meetings with school board, meetings with central office administration, meetings with parents, survey)

Commendations

1. The principal has sufficient autonomy from the superintendent and school board
2. Development of creative and unleveled courses
3. Level of trust and support between administration and faculty
4. Degree of caring exhibited by all staff members toward students
5. Student recognition

Recommendations

1. Increase genuine participation in the decision-making process for all school and community constituents
2. Ensure that all students, no matter the course or the level, have multiple opportunities to practice higher order thinking and to be involved in problem solving
3. Establish daily teaching loads that support the need for personalized education and empower and enable all teachers to use contemporary teaching techniques that allow the learning needs of all students to be met
4. Implement a formal comprehensive program which personalizes the educational experience for every student and provides an adult in addition to the guidance counselor who can assist the student in achieving the expectations in the mission

SUPPORT STANDARD

6 School Resources for Learning

Student learning and well-being are dependent upon adequate and appropriate support programs and services. The school is responsible for providing an effective range of integrated resources to enhance and improve student learning and well-being and to support the school's mission and expectations.

All Student Support Services

1. The school's student support services shall be consistent with the school's mission and expectations for student learning.

2. The school shall allocate resources, programs, and services so that all students have an equal opportunity to achieve the school's expectations for student learning.

3. Student support personnel shall enhance student learning by interacting and working cooperatively with professional and other staff and by utilizing community resources to address the academic, social, emotional, and physical needs of students.

4. All student support services shall be regularly evaluated and revised to support improved student learning.

5. There shall be a system for effective and ongoing communication with students, parents/guardians, and school personnel, designed to keep them informed about the types of available student support services and identified student needs.

6. Student records, including health and immunization records, shall be maintained in a confidential and secure manner consistent with federal and state law.

7. There shall be sufficient certified/licensed personnel and support staff to provide effective counseling, health, special education, and library media services.

Guidance Services

8. The school shall provide a full range of comprehensive guidance services, including:

   - individual and group meetings with counseling personnel;
   - personal, career, and college counseling;
   - student course selection assistance;
   - collaborative outreach to community and area mental health agencies and social service providers;
   - appropriate support in the delivery of special education services for students.

Health Services

9. The school's health services shall provide:

   - preventive health services and direct intervention services;
   - appropriate referrals;
   - mandated services;
   - emergency response mechanisms;
   - ongoing student health assessments.

Library Information Services

10. The library/information services program and materials shall be fully integrated into the school's curriculum and instructional program.

11. Library/information services personnel shall be knowledgeable about the curriculum and support its implementation.

12. A wide range of materials, technologies, and other library/information services that are responsive to the school's student population shall be available to students and faculty and utilized to improve teaching and learning.

13. Students, faculty, and support staff shall have regular and frequent access to library/information services, facilities, and programs as an integral part of their educational experience before, during, and after the school day.

14. The library/information services program shall foster independent inquiry by enabling students and faculty to use various school and community information resources and technologies.
15. Policies shall be in place for the selection and removal of information resources and the use of technologies and the Internet.

Special Education Services

16. The school shall provide special education services related to the identification, monitoring, and referral of students in accordance with local, state, and federal laws.

School Resources for Learning

Conclusions:

TRHS's Student Support Services complement the school's mission and expectations for student learning by supporting and facilitating the implementation of the academic, civic and social expectations. Collaboration and cooperation are demonstrated by guidance and special education personnel interacting with faculty and staff members to provide appropriate educational opportunities for students. The school's two full-time nurses provide preventive and direct intervention services and also provide appropriate referrals, mandated services, emergency responses, and ongoing health assessments, which foster students' academic, personal, creative and social growth. The personnel in the media center work cooperatively with teachers and other staff members in support of the curriculum. Overall, the level of student support services effectively supports the school's mission and expectations for student learning. (Self-study, Shadowing, Panel presentation, Facility tour, Meetings with teachers, Meetings with parents, Meeting with School Board, Meetings with department leaders, Meetings with school support staff)

The school sufficiently funds most resources, programs, and services so that all students have an equal opportunity to achieve the school's expectations for student learning. The school board is committed to allocate resources to improve student achievement. Funding appears adequate for continued technology development in the media center but lacking in some classrooms. Existing technology is replaced on a five-year plan. The health office is well-staffed and adequately equipped. The guidance department members have reasonable case loads. Special education personnel are certified and moving towards a more inclusive model. School resources cover all students and provide for equal access to student services. (Classroom observation, Self-study, Facility tour, Meetings with teachers, Meetings with students, Meetings with parents, Meetings with community members, Meetings with department leaders, Meetings with school support staff)

Guidance counselors, the school nurses, special education teachers, and paraprofessionals work together and cooperate with other faculty members in addressing academic, social, emotional, and physical needs of students, thereby enhancing student learning. Guidance counselors, student assistance counselors, adjustment counselors (full-time social workers), and nurses also refer students to community resources and outside agencies as needed. For example, students receive services from: Exeter Counseling Center, Greenleaf Woods Counseling, Center for Life Management, and RMB Counseling Associates. The school's library media specialist works with the faculty to provide resources for special projects, units of study, and research projects. Student support personnel involve members of the faculty and staff as well as community resources when appropriate. These service providers support students to address their academic, social, emotional, and physical needs. (Classroom observation, Panel presentation, Teachers, Meetings with teachers, Meetings with department leaders, Meetings with central office administration, Meetings with school support staff)

Student support services at TRHS are evaluated both formally and informally. However, not all services have been adequately revised to support improved teaching and learning. The guidance department provides annual surveys to seniors to evaluate guidance services. Freshmen are surveyed to evaluate the transition to high school program, but it is not clear how this feedback is used to improve delivery of services. Currently, there is not sufficient formal evaluation conducted by the media center to improve services offered. Health services staff members and programs are evaluated every two years and the immunization program is evaluated by the state each year. The special education department completed the State of New Hampshire review in 2006 and was granted a five-year approval. Overall, the guidance department is in need of further evaluation and revision in order to more fully support teaching and learning in a more focused manner. (Self-study, Meetings with teachers, Meetings with students, Meeting with School Board, Meetings with school support staff)

Student support services staff members provide clear and continuous communication through a variety of media. Both the school and individual student support services departments maintain an updated website and a community access channel on television (T.E.N.) and provide several publications both in print and on-line. Report cards and progress reports are sent home four times during the school year. Parents and teachers have access to student performance through "Power School." The guidance department schedules grade-specific parent information programs to share relevant information regarding student services. These communication sources help keep parents, students, and faculty members apprised of general information, policies, upcoming events, deadlines, and requirements. (Self-study, Panel presentation, Meetings with teachers, Meetings with school support staff)

Student records are maintained in a confidential and secure location. Cumulative student records are maintained five years after graduation. Student health records are kept in a secure computer program accessible only by health services staff members. All media center records are maintained on a secure network. Special education records are maintained in locked cabinets in the special education office. These records are maintained for eight years from the date of discharge. Teachers are sent an electronic copy of a student IEP, thus maintaining confidentiality. Maintenance of student records is consistent with federal and state laws and assures student confidentiality. (Self-study, Panel presentation, Facility tour, Meetings with teachers, Meetings with school support staff)

The student support staff is fully certified to provide effective counseling, health, special education, and library/media services. All five guidance counselors and one director are fully certified through the department of education. The two nurses are registered nurses in accordance with state and federal laws. The media specialist is fully certified, as are the two media center paraprofessionals. The special education department has twenty two certified instructors and fifteen certified paraprofessionals. Sufficient certified staff is able to provide effective services for all students. (Self-study, Panel presentation, Teachers, Meetings with teachers, Meetings with department leaders, Meetings with central office administration, Meetings with school support staff)

The school has a full range of services offered by guidance staff, school psychologists, and social workers to support students and deliver services. All students are seen at least twice a year by the guidance staff. Juniors and seniors are seen more often for post high school/college planning. Students are assisted with course selection by the guidance staff. Students needing assistance are referred to the Student Assistance Program. Referrals are made to appropriate outside agencies as needed. Student assistant and adjustment counselors support regular and special education students with learning centers and tutors [note separation of SAP and adjustment people]; small group counseling seminars take place as part of the comprehensive guidance plan. The guidance and special education departments deliver services to students to support student success and learning. Outside agencies are referred to where needed. The senior survey has resulted in positive ratings for the guidance services offered although student meetings indicated that some students felt the guidance office was not approachable. All students must be encouraged to take advantage of guidance services in a welcoming environment. (Self-study, Panel presentation, Teachers, Meetings with teachers, Meetings with students, Meetings with department leaders, Meetings with school support staff)

Students, parents, and teachers indicate that the school health services provided are satisfactory and a variety of preventive health services and direct intervention services are offered. Participation in the referral system-mandated services is an integral part of the school community as are ongoing health assessments for students. The preventive health services provide 10th grade health screenings in hearing, eye, and vision along with day to day intervention services. When appropriate, the nurse makes referrals to guidance, administration, special needs, and local primary healthcare services. There are currently 12 students on individual health plans. Emergency response guides are located on the walls in every classroom. CPR and AED training for all district staff is offered five times per year, training fifty percent of the staff so far. There are three automatic defibrillators on site. The health services have two preventive programs "Blood Pressure Program" and "Not on Tobacco." Staff program include Healthy Heart program, Weight Watchers, and a walking program. The nurse serves as a liaison to the School Safety Committee and to local and state health departments. School health services are delivered on a regular basis. Healthy students make better learners; however student record-keeping and visits are limited by a limited secretarial staff, which results in records not being maintained up-to-date. (Self-study, Facility tour, Meetings with teachers, Meetings with central office administration, Meetings with school support staff)

The library/information services program and materials are integrated in some areas of the school's curriculum and instructional programs. Services are provided informally to interest and "sought after" teachers, through e-mail and personal contact; through these contacts, the librarian works earnestly to integrate research skills with curriculum. The librarian has cultivated a welcoming and focused information center for students and staff members. Teachers and library staff members state that a draft form of a research rubric which is part of the information literacy curriculum and the mission statement is being phased into the social studies department during the 2007-2008 school year in a limited way. Other departments are expected to follow although there is no articulated time-line for any department. The librarian looks forward to further integration of this rubric throughout the school. Book purchases are made based on curriculum needs and wants. Library/information services are offered on a formal and informal basis to all staff members and students. Collaboration through the media center supports curriculum implementation in classrooms thus supporting the learning needs of students. (Self-study, Shadowing, Panel presentation, Meetings with teachers, Meetings with students, Meetings with central office administration, Meetings with school support staff)

Teacher and library staff interviews show that the library/information personnel are knowledgeable in the curriculum area and actively support its implementation. The media specialist is certified as both a media specialist K-12 and in education. The American Association of School Librarians 21st Century Learner standards are being used as the benchmark for the district technology literacy program curriculum integration. The knowledge of the library/information personnel facilitates student learning and curriculum integration in some areas. (Self-study, Teachers, Meetings with teachers, Meetings with parents, Meetings with school support staff)

Sufficient materials, technologies, and other library/information services are responsive to the school's student population. These materials are available to students and faculty members and are used in some areas to improve teaching and learning. The library staff is providing materials, technologies and other library services on a daily basis. Materials are purchased to align with the curriculum. Teachers are targeted to use the materials. The students benefit by the recent expansion of the library and the resources contained within. The wealth of materials, technologies and other library/information services is actively enabling students and teachers to integrate various resources into their subject matter and research to improve teaching and learning. (Self-study, Teachers, Meetings with teachers, Meetings with school support staff)

Students, faculty, and support staff members have access to library/information services, facilities, and programs as an integral part of their education experience, before, during, and after the school day. Students, teachers, and staff members have access to the library before school, during study halls (with a pass), free periods (seniors) during library lunch, and after school with the notable exception of the Evening Division. The Media Center is open from 7:00 – 3:15 everyday. After school many students use this area for homework, especially the athlete tutoring program. On average, seven classes a day used the Media Center, plus other students who come in during their free block or study halls in the main room. Seven classes also use the computer lab area. Class use depends upon the interest and willingness of individual teachers to incorporate research into their curriculum. However, student survey data from 2006-2007 indicate that 59% of students does not feel they use the library often during classes. Consistent access to the media center for all programs enhances student learning experience. (Self-study, Panel presentation, Teachers, Meetings with students, Meetings with school support staff)

The media center at TRHS provides a wide range of materials, technology, and other library/information resources available in a variety of formats. The media specialist has purchased many materials to attract students, including books on mp3 players. Circulation records show increased use of the media center by students and staff members. Both students and staff members believe that the library materials are up-to-date. Most students gain access to the media center through scheduled class time, ninth grade orientation, and use of the media center's computer lab. They also have access to the media center during study hall time and after school hours. Students and the school community access various resources readily available in the media center, fostering greater independent inquiry. (Self-study, Shadowing, Facility tour, Meetings with teachers, Meetings with school support staff)

The media center has an adequate acceptable use policy for the access of computer technology by students. A signed acceptable use policy is required of all students, and their parents must sign a copy of this policy for students to access computer and Internet technologies. There is a filter in place to block selected Internet sites although this has caused some valid research sites to be unavailable. The library/media center has a policy for selection and removal of print and non-print material from circulation, but the policy should be revised to reflect current best practices. The media center collection selection is based on teacher requests, student interests, and curriculum. As a result, the opportunity for students to access up-to-date resources that apply to current studies and course offerings is acceptable. (Self-study, Facility tour, Meetings with teachers, Meetings with school support staff)

TRHS provides a full range of education referral and special education services that comply with state and federal laws**.** TRHS has a special education evaluation and placement team (SEEPT) to coordinate student referrals made by teachers or parents. All school personnel and parents are able to monitor student progress using Power School. Special education teachers collaborate with subject-area teachers to make appropriate accommodations for students in need of services, and disseminate electronically the accommodation plans for each student. All subject area teachers are given opportunities to provide input and observations regarding student progress and are invited to attend all special education and academic support service meetings during the school day. As a result of this collaboration between special education, support services, and subject area teachers, students in need of academic and other support services are placed according to their individualized education plans, however. Special and regular education teachers have expressed concerns about the ratio of identified students within the inclusion model and have appealed to the administration for a change in practice. (Self-study, Meetings with teachers, Meetings with school support staff)

Commendations

1. The high volume of users and wide spectrum of services and programs offered through the health services department
2. The existing plan to upgrade existing technology on a five-year schedule
3. Support of the curriculum through the media center
4. The variety of library/media center learning resources that are designed to support student needs
5. The welcoming attitude and work ethic exhibited by the media center staff

Recommendations

1. Develop formal program evaluation tools to garner feedback to improve services in the guidance department
2. Provide additional administrative support in the health office and the media center to maintain records and better serve the needs of students
3. Increase personalization of and access to services in the guidance area
4. Provide appropriate media center access for students participating in the Evening Division
5. Update the methods used for maintaining the library media collections
6. Increase seating in the media center to accommodate more than one class at a time
7. Evaluate the ratio of regular education to special education students in inclusion/co-taught courses to ensure that it complies with state and federal regulations as well as current research in best practice

SUPPORT STANDARD

7 COMMUNITY RESOURCES FOR LEARNING

Active community and parent participation, facilities which support school programs and services, and dependable and adequate funding are necessary for the school to achieve its mission and expectations for student learning.

1. The school shall engage parents and families as partners in each student's education and shall encourage their participation in school programs and parent support groups.

2. The school shall foster productive business/community/higher education partnerships that support student learning.

3. The school site and plant shall support and enhance all aspects of the educational program and the support services for student learning.

4. The physical plant and facilities shall meet all applicable federal and state laws and shall be in compliance with local fire, health, and safety regulations.

5. Equipment shall be adequate, properly maintained, catalogued, and replaced when appropriate.

6. A planned and adequately funded program of building and site management shall ensure the appropriate maintenance, repair, and cleanliness of the school plant.

7. There shall be ongoing planning to address future programs, enrollment changes, staffing, facility, and technology needs as well as capital improvements.

8. The community and the district's governing body shall ensure an adequate and dependable source of revenue to provide and maintain appropriate school programs, personnel, services, facilities, equipment, technological support, materials, and supplies for student learning.

9. Faculty and building administrators shall have active involvement in the budgetary process, including its development and implementation.

Community Resources for Learning

Conclusions

TRHS engages some parents and families as partners in their students' education and encourages their participation in school programs and parent support groups. TRHS uses the Internet with programs such as PowerSchool, the TRHS website and the use of e-mail to enable parents with computers to connect easily and directly with the school. TEN (Timberlane Educational Network) provides the community with access to information about meetings, sports, and theater events on television. The principal has recently initiated parent "coffees" once a semester, as another way parents are encouraged to become involved in the school. Parents of seniors work to facilitate a chemical-free after-prom party. Additionally, they have created a dress donation program to enable students in need to get a prom dress. Music boosters, who were instrumental in the development of the Performing Arts Center (PAC), as well as the sports boosters, and PTSA, provide additional vehicles for parental involvement. While these opportunities exist, survey results show that only one-third of the parents participate in school programs and organizations. To address the need to have greater parental involvement the administration and staff must direct more effort toward further parental engagement, particularly for parents who do not own computers. For the benefit of student learning, TRHS needs to continue to foster the partnership between ALL parents and the school. (Classroom observations, Meetings with teachers, Meetings with students, Meetings with parents, Survey)

TRHS fosters business, community and higher education partnerships. TRHS is affiliated with many community business organizations, such as Plaistow Area Commerce Exchange (PACE), Pre-Engineering Technology Curriculum Advisory Council (PETAC), Atkinson/Plaistow Lion's Clubs, Raytheon, and other local businesses that provide athletic score boards and snow removal. TRHS is also working with diverse local organizations like the Safe and Drug Free Coalition (intervention programs), the Boy Scouts, and The Red Cross (blood drive). Some students are also engaged in the local community by performing community service projects as internships through the school. The existence of these partnerships supports the educational opportunities of TRHS students. (Self-study, Panel presentation, Facility tour, Meetings with teachers, Meetings with school leadership team, Meetings with school support staff)

The present school site and plant do not adequately support all aspects of the educational program and the support services for student learning. Although TRHS added a new wing in 2001 with 16 classrooms to accommodate the increase enrollment in the high school, expanded the cafeteria, and updated the science lab furniture and equipment, the school needs to provide more rooms appropriately designed for Special Education and Science as well as school-wide. There are sixteen Special Education teachers and only ten special education rooms. There are ten science classrooms for fourteen science teachers, and there are nine math classrooms and fifteen math teachers. There are similar statistics in other departments such as art and foreign language. Students are losing teaching time because teachers have to travel from classroom to classroom. Despite the expansion, the cafeteria now must support six lunch periods to accommodate all the students. This drives the schedule, and the lunch periods are short, barely giving students enough time to eat despite the implementation of four food stations to allow students to get their food quickly. The school needs to design and implement improvements in the physical education locker rooms (too small with too few showers), gyms (too small to handle two or more large classes engaging in movement-oriented activity), and the weight room (wall repair needed). It needs to provide more meeting rooms, especially for guidance and special education. More classrooms are needed in most of the academic areas; for example, currently, there is a science class meeting in a shop area. There is a problem with vehicle traffic congestion in the mornings and afternoons outside the school, creating what might be a safety issue. Student learning in the areas noted is compromised by the inadequate present facility. (Classroom observations, Shadowing, Facility tour, Teachers, Meetings with teachers, Meetings with school leadership team, Meetings with school support staff)

Most of the physical plant and facilities at TRHS are in compliance of the local fire, health, and safety regulations, but there are ADA mandates that must be fulfilled. There are three Life Pak defibrillators in the school with most of the coaches and numerous others trained in their use. A sprinkler system and fire extinguishers throughout the school brings it into compliance with fire regulations. In accordance with the Fire Chief and State Fire Marshall, chemicals and flammable liquids are stored in approved locations. There are materials safety data sheets (MSDS) for all chemicals available to personnel, including the nurse, teachers and staff members. New security cameras have been added on the roof and near entry doors as well as new external lighting. A new roof was added last year on the old part of the school which has alleviated the majority of leakage and mold problems. Braille system signage has been posted in the school. Some of the school has been made handicapped accessible, but the sinks, counter-tops and cabinets in the special education rooms are not in compliance with American with Disabilities Act (ADA) mandates nor are all the bathrooms and all the doors compliant. There are persistent heating and ventilation problems. There is a safety concern regarding the fact that the announcements on the intercom in case of emergency situations cannot be heard in al rooms. TRHS must complete its efforts to bring its physical plant and facilities into compliance with all applicable federal and state laws and to be in compliance with local fire, health, and safety regulations to facilitate the safety of all students and personnel and to support the curriculum and give students the opportunity to meet the expectations found in the school's mission. (Classroom observations, Self-study, Facility tour, Teachers, Meetings with teachers, Meetings with school support staff)

Equipment at TRHS is properly maintained, catalogued, and replaced when necessary, although the addition of more computers in the classrooms, more laptop computers, and more equipment would further enhance the quality of education. Many classrooms would benefit from the addition of computers other than just that of the teacher in the classroom, making them available for student use so that technology could contribute to instruction. There are currently three laptop computers available in the Library and there is a high demand for them. The science department has one computer for every two students. Regular maintenance of technology equipment is done on a rotating schedule (five-year cycle). The Maintenance Direct Software Program is used by the faculty and staff to manage work orders to maintain the computers. Microscopes and Pasco Measuring and Data System with Clean Harbors handles chemical waste disposal once a year. A paraprofessional in the science department is responsible for maintaining its supplies and inventorying its equipment. The media specialist, in conjunction with the library assistants, monitors and maintains the audiovisual equipment via both a school and a district bar-coding system. A formal inventory of all the equipment owned by the high school and repair records are maintained at the SAU. The district technology coordinator and her in-school staff maintain the information technology equipment, including software licenses. Repairs that cannot be done in-house are outsourced. Increased technology and equipment needs to be added to TRHS to create better educational opportunities for all students. (Self-study, Facility tour, Teachers, Meetings with teachers)

Neither funding nor building and site management are adequate to ensure appropriate maintenance, repair, and cleanliness of the school plant. There is currently one daytime custodian from six to ten-thirty in the morning with another coming on at ten-thirty. There are six evening janitors. Cleanliness, maintenance and daily repairs are needed. The bathroom floors and sinks are not clean, nor are they fully functioning. The waste cans are over-flowing with trash on a Sunday after vacation; there are stalls where the doors did not close properly and the waste receptacles in the women's bathroom are falling off the bathroom stalls, and there is no door at all on the toilet in the girl's locker room. In the men's locker room, hot water is being used in both faucets of the sinks and also in the toilet. Several water fountains in the hallways do not work properly or are broken. The dumpsters are located directly outside the cafeteria kitchen, allowing insects to enter the kitchen. In the home economics kitchen, there are ants crawling all around the baseboard. In the science labs, some sinks are not fully functioning and they are filled with debris. Additionally, the gas jets do not work properly in all the labs and, in one case are plumbed incorrectly, thus posing a safety hazard necessitating the system to be entirely shut off which is detrimental to learning. Despite work being done to improve the heating and ventilation system and the addition of a new roof, more maintenance must be done to solve the problems. Areas of the roof still leak and the heating and ventilation systems still work unevenly. Although there recently was a work order method of tracking and prioritizing problems implemented for the staff to use, it is often not currently leading to change due to funding and capacity. It is imperative for safety reasons and the morale of the students and teachers that continuous attention to maintenance, repair and cleanliness of the school be provided. (Classroom observations, Shadowing, Facility tour, Teachers, Meetings with teachers, Meetings with department leaders)

There is no capital improvement plan for the next five to ten years to effectively meet the needs of the current and future programs, facility, and technology. Congestion with traffic in the parking lots is a safety issue that needs to be addressed. A grant has been applied for in relation to this called "Safe Routes to Schools". Currently, there is a strategic planning committee comprised of community members, administrators from district schools and students to anticipate and plan for future needs in the district. The district has recently hired a consultant to help in planning. TRHS needs are addressed every year when the principal submits a prioritized list of needs gathered from all the departments within the school to the superintendent. The budget is presented to the district budget committee, and a determination is then made as to what can be accomplished within the budgetary constraints of that particular year. A capital improvement plan needs to be developed to meet the current needs and improve the quality of life and education at TRHS. (Self-study, Meetings with teachers, Meetings with parents, Meetings with school leadership team)

The current budget is not adequate to maintain facilities, provide additional space, the appropriate programs, supplies and materials at TRHS. Two modular classrooms, a new wing and expanded cafeteria space have been added, but more are needed to support an adequate education. At TRHS, the average spending per student ($8,822) is lower than the state average ($9,431). The self-study indicates that supply shortages such paper and other materials exist before the end of the school year. Furthermore, the inadequate funding is corroborated in a survey where sixty percent of the staff feels that the physical plant is not conducive to education. Limited resources prevent staff members from properly meeting the curriculum, instructional, and assessments needs of students. (Classroom observations, Self-study, Shadowing, Panel presentation, Facility tour, Teachers, Meetings with teachers, Meetings with students, Meetings with parents, Meetings with department leaders, Meetings with school support staff, Survey)

Faculty and building administrators are actively involved in the budgetary process. The school budget at TRHS begins at the school level. It is a needs -based budget in which the teachers provide a list of justifiable needs to their department leaders. Usually in September those leaders forward their proposed budget to the principal. The principal analyzes and organizes these budget requests and combines them with additional requests for facility needs and staffing and submits them to the superintendent, who reviews them. The principal and superintendent meet and make adjustments to the proposal before presenting it to the budget committee and school board in early October. A collaborative budget process contributes to alignment of spending with critical building needs. (Self-study, Panel presentation, Meetings with teachers, Meetings with department leaders, Meetings with school leadership team)

Commendations

1. Active support of the music boosters in inspiration for and creation of the PAC
2. The support and involvement of the members of the community provided by local businesses
3. The collaborative budget process

Recommendations

1. Comply fully with ADA handicapped access.
2. Increase technology and equipment
3. Provide a facility and faculty that support all aspects of the curriculum that exists today and will be needed in the future and meets the needs of all student learners
4. Complete all repairs to the roof
5. Immediately address all health and safety issues including ADA regulations and cleanliness
6. Investigate and propose solutions for school safety issues related to traffic congestion outside the school
7. Develop, fund and implement a plan for maintenance and on-going repairs of the facilities
8. Develop a new five to ten year capital plan for improvement of the facilities
9. Provide consistent funding for supplies

FOLLOW-UP RESPONSIBILITIES

This comprehensive evaluation report reflects the findings of the school's self-study and those of the visiting committee. It provides a blueprint for the faculty, administration, and other officials to use to improve the quality of programs and services for the students in Timberlane Regional High School. The faculty, school board, and superintendent should be apprised by the building administration yearly of progress made addressing visiting committee recommendations.

Since it is in the best interest of the students that the citizens of the district become aware of the strengths and limitations of the school and suggested recommendations for improvement, the Commission requires that the evaluation report be made public in accordance with the Commission's Policy on Distribution, Use and Scope of the Visiting Committee Report.

A school's initial/continued accreditation is based on satisfactory progress implementing valid recommendations of the visiting committee and others identified by the Commission as it monitors the school's progress and changes which occur at the school throughout the decennial cycle. To monitor the school's progress in the Follow-Up Program the Commission requires that the principal of Timberlane Regional High School submit routine Two- and Five-Year Progress Reports documenting the current status of all evaluation report recommendations, with particular detail provided for any recommendation which may have been rejected or those items on which no action has been taken. In addition, responses must be detailed on all recommendations highlighted by the Commission in its notification letters to the school. School officials are expected to have completed or be in the final stages of completion of all valid visiting committee recommendations by the time the Five-Year Progress Report is submitted. The Commission may request additional Special Progress Reports if one or more of the Standards are not being met in a satisfactory manner or if additional information is needed on matters relating to evaluation report recommendations or substantive changes in the school.

To ensure that it has current information about the school, the Commission has an established Policy on Substantive Change requiring that principals of member schools report to the Commission within sixty days (60) of occurrence any substantive change which negatively impacts on the school's adherence to the Commission's Standards for Accreditation. The report of substantive change must describe the change itself and detail any impact which the change has had on the school's ability to meet CPSS Standards. The Commission's Substantive Change Policy is included in the Appendix on page 60. All other substantive changes should be included in the Two- and Five-Year Progress Reports and/or the Annual Report which is required of each member school to ensure that the Commission office has current statistical data on the school.

The Commission urges school officials to establish a formal follow-up program at once to review and implement all findings of the self-study and valid recommendations identified in the evaluation report. An outline of the Follow-Up Program is available in the Commission's *Accreditation Handbook* which was given to the school at the onset of the self-study. Additional direction regarding suggested procedures and reporting requirements is provided at Follow-Up Seminars offered by Commission staff following the on-site visit.

The visiting team wishes to express its gratitude for the quality of the self-study and the pre-visitation effort and for the hospitality that was afforded during the visitation. All of the accommodations were thoughtfully arranged and the warmth conveyed by the Timberlane Regional family is recognized and acknowledged.

NEW ENGLAND ASSOCIATION OF SCHOOLS AND COLLEGES

Commission on Public Secondary Schools

Appendix A

SUBSTANTIVE CHANGE POLICY

Principals of member schools must report to the Commission within sixty (60) days of occurrence any substantive change in the school which has a *negative impact* on the school's ability to meet any of the Commission's Standards for Accreditation. The report of a substantive change must describe the change itself as well as detail the impact of the change on the quality of education in the school. The following are potential areas where there might be negative substantive changes:

- available programs, including fine arts, practical arts and student activities
- available facilities, including upkeep and maintenance
- level of funding
- school day and/or school year
- administrative structure, including the number of administrators and supervisors
- number of teachers and/or guidance counselors
- number of support staff
- student services
- the use of distance educational programs or courses
- educational media services and personnel
- student enrollment

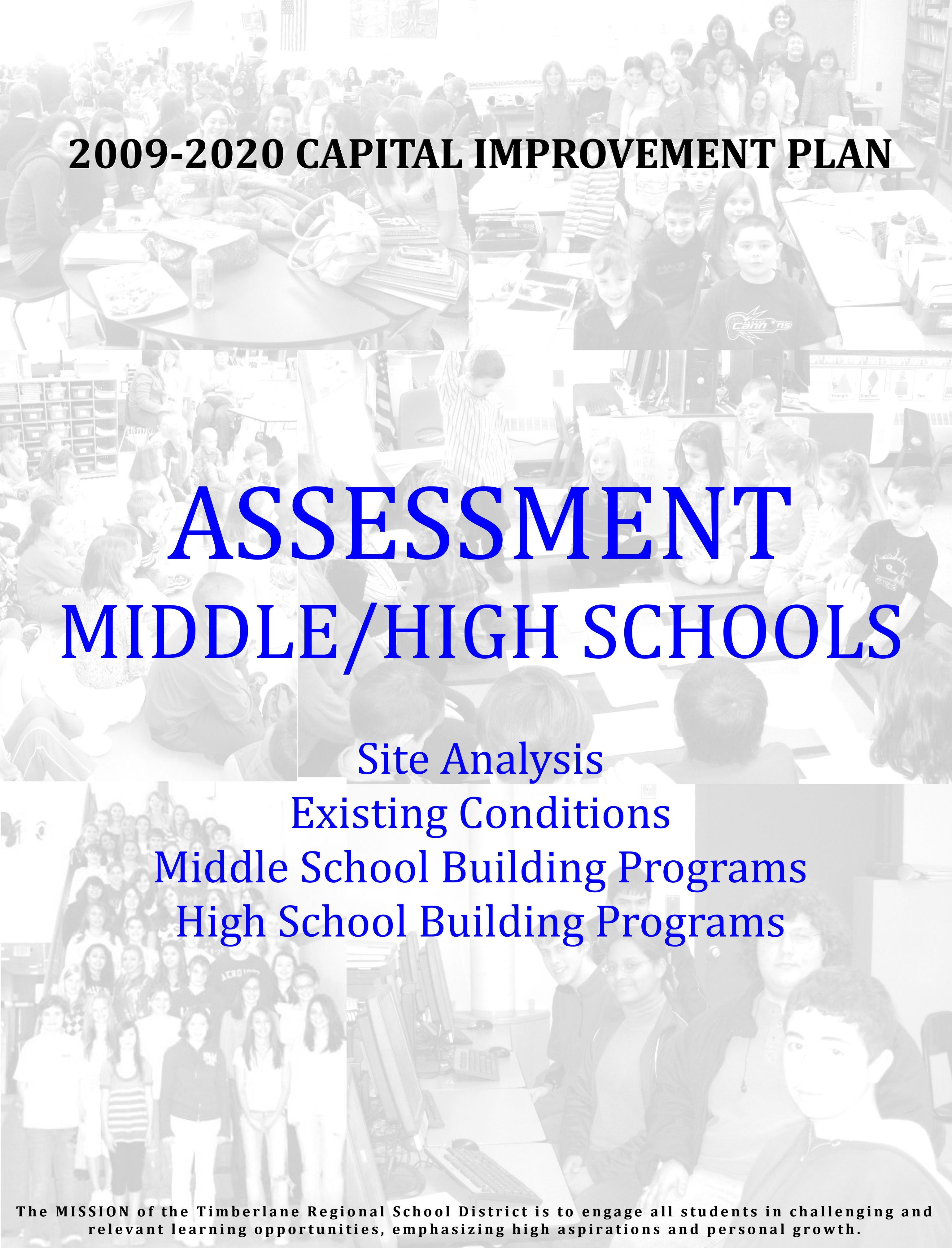
- grades served by the school

- the student population that causes program or staffing modification(s), e.g., the number of special needs students or vocational students or students with limited English proficiency.

Appendix B

Visiting Team Members

Mr.	Richard	Kraemer	Retired Principal	137 Carpentier Farm Road	Morrisville, VT 05661
Ms.	Colleen	Meaney	Souhegan High School	412 Boston Post Road	Amherst, NH 03031
Mr.	Eugene	Connolly	Concord High School	170 Warren St.	Concord, NH 03301
Ms.	Tina	John	Belmont High school	221 Belmont Avenue	Belmont, MA 02478
Mr.	Stephane	Debovzy	Glister High School	32 Leslie O. Johnson Road	Gloucester, MA 01930
Ms.	Sandra	Samaha	Masconomet Regional High School	120 Endicott Road	Topsfield, MA 01983
Ms.	Michelle	Heath	Fall Mountain Regional High School	134 FMRHS Road	Langdon, NH 03602
Mr.	David	Rea	Laconia High School	345 Union Avenue	Laconia, NH 03246
Mr.	David	Hardy	Stevens High School	175 Broad Street	Claremont, NH 03743
Ms.	Carol	Brown	John Stark Regional High School	618 N. Stark Hwy.	Wears, NH 03281
Mr.	David	Cook	Billerica Memorial High School	35 Boston Road	Billerica, MA 01821
Mr.	Peter	Weaver	Winnacunnet High School	1 Alumni Drive	Hampton, NH 03842
Mr.	Matt	Do iron	Sanford High School	52 Sanford High Blvd.	Sanford, MA 04073
Mr.	Wayne	Ogden	Franklin Public Schools	355 E. Central Street	Franklin, MA 02038
Ms.	Jean	D'Orsi	Methuen High School	1 Ranger Road	Methuen, MA 01844
Ms.	Stephanie	Hassapes	Merrimack Valley High School	106 Village Street	Penacook, NH 03303
Mr.	Mark	MacLean	Portland High School	284 Cumberland Avenue	Portland, ME 04101



2009-2020 CAPITAL IMPROVEMENT PLAN

ASSESSMENT

MIDDLE/HIGH SCHOOLS

Site Analysis
Existing Conditions
Middle School Building Programs
High School Building Programs

The MISSION of the Timberlane Regional School District is to engage all students in challenging and relevant learning opportunities, emphasizing high aspirations and personal growth.

TIMBERLANE REGIONAL SCHOOL DISTRICT

Middle and High School Campus

SCALE 1" = 200'-0"

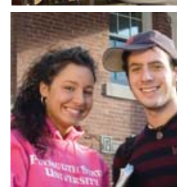
N

September 30, 2008

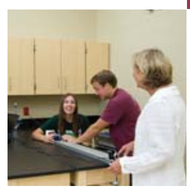
Lavallee Brensinger ARCHITECTS

EDUCATION DESIGN GROUP

Existing Conditions Assessment



TIMBERLANE REGIONAL
SCHOOL DISTRICT (SAU 55)



Timberlane Middle School and
High School Existing Facilities
Assessment and Conceptual Planning

October 20, 2008

Lavallee
Brensinger
ARCHITECTS

Your mission inspires us. Our creativity and knowledge empower you. **Together we achieve excellence.**

Lavallee Brensinger Architects 155 Dow Street, Suite 400 Manchester NH 03101 tel 603-622-5450 fax 603-622-7908 web LBPA.com

Lavallee Brensinger ARCHITECTS

Timberlane Regional Middle School and Timberlane Regional High School
Existing Conditions Assessments

- Architect's Assessment

    -Site Assessment

    -Middle School Assessment

    -High School Assessment

- Consulting Engineer's Reports

    -Structural Engineer's Reports

    -Electrical Engineer's Report

    -Mechanical Engineer's Report

Timberlane Middle School and High School October 20, 2008
Existing Condition Assessments

Lavallee Brensinger Architects offers the following assessment of the existing Timberlane Regional School and Site Facilities. This report is based on meetings with the School Administrators and the Facilities Director, site visits, including a full building tour of the facilities by Lavallee Brensinger Architects and their consulting engineers, and a review of the most recent floor plans. The facility has been reviewed, and recommendations based on, current design practices, current code compliance, and current Educational guidelines as published by the State of New Hampshire Department of Education.

Site Assessment:

The High School and Middle School share a site with the Performing Arts Center at 36 and 44 Greenough Road in Plaistow, NH. The vehicular approach to the property is via Greenough Road which runs parallel with the frontage of the three buildings. Traffic and safety management appears to be a constant task for the schools, given that on-site traffic for all three buildings converges on the same site. Traffic signs separate patterns for auto drop-off, bus drop-off, and student/staff access and parking, but these patterns are complex and somewhat confused, and could benefit from dedicated ingress/egress and physically separated lanes.

Parking appears to be insufficient to meet the current volume of staff and student drivers. There are a number of cars that park along Greenough Road from the school site to the SAU office. This condition is a significant safety concern and should be resolved through either expansion of on-site parking or limitations on number of student drivers.

The primary water supply is via a drilled well, located approximately 13 feet off the northeastern property line and approximately 130 feet from the Maintenance Building. Current NH Department of Environmental Services regulations require a 200 foot protective radius around potable water wells for property lines, 400 feet from any fuel storage below ground, and 75 feet from any fuel storage above ground (including any small storage amounts that may exist within a Maintenance Building). While this well is allowable under a grandfathered status, it does not meet current DES protective setback requirements. Any proposed additions or improvement to the campus should include a cost analysis of a new well and consideration of the best location. (Should this be deemed necessary by the State of NH, either now or in the future). Continuation of the District's current monitoring program will ensure that this water supply will remain safe for consumption.

The athletic fields are currently located behind (North of) the Middle School buildings and East of the High School. As with most districts in New Hampshire, the demands for fields has grown, causing the

District to choose between either restricting athletic/recreational use, or over-using the existing fields. The property where the fields are located is flat and well suited for athletic fields. Access to the fields is via the SAU office and through the Middle School, High School and PAC campus, further compounding traffic issues for any early games during school release hours. A second access off East Road or Route 125 would alleviate much of this congestion. This second access would also enhance emergency access to the facilities. To accomplish an access from East Road or Route 125, several of the adjacent properties have been preliminarily evaluated. A site walk and visual observation on September 19, 2008 showed wetlands exist on many of these properties. This observation was confirmed with data from the New Hampshire Geographically Referenced Analysis and Information Transfer System (NH GRANIT). At this time, we believe that the district would benefit from acquiring additional property to accomplish secondary or primary access points from East Road or Route 125 and perhaps to supplement property available for athletic fields or future building projects. Both the possibility of purchasing any of the adjacent properties and the possibility of improvements (and any related wetlands mitigation required) will be further addressed through a site planning exercise and coordination with the District, the Towns, and the State.

Timberlane Regional Middle School

Building Condition:

The building was originally built in 1975 and has undergone three additions (1984, 1996, and 2000) bringing the building to a total size of 127,617 sf. The efforts of the Maintenance Staff to not only maintain this building, but to provide ongoing improvements, are evident. Interior floor and wall finishes are in excellent condition for their age. The roof of the facility is fairly new with additional insulation added during the recent roofing replacement. The exterior wall insulation appears to be reasonably adequate (pending verification), but there are many windows and doors that remain no-thermally broken with single pane glazing which significantly effects energy efficiency. It is evident while touring the facility that the suspended ACT ceilings are in need of a full replacement. Throughout the school, ceiling tiles are sagging, and do not have the acoustic properties of those currently recommended.

The overall building infrastructure is difficult to fully assess as many improvements have been made in selected areas, yet the original 1975 vintage systems infrastructure generally remains. Electrical and lighting improvements have been implemented, yet would be impractical to retain if the building were to undergo a significant renovation. Telephone, intercom and IT systems, again, have been selectively upgraded, but many shortcomings remain, primarily related to the integration of these systems, which is now mainstream technology included in new, or renovated, middle school facilities. It should be noted that the District has implemented a technology improvement program which has made significant improvements, but the restrictions of the underlying, aged, systems remain. Per the

Electrical Engineer's building assessment, lighting systems and the primary electrical service for the Middle School are due for a full replacement.

The heating and ventilation systems have, similarly, undergone select upgrades in certain areas. Overall, the mechanical systems do not meet current standards for air-changes and energy efficiency.

Structurally, the building is sound, but does not meet current code requirements for seismic loading. As noted in the Structural Engineer's assessment of the facility, substantial renovations or additions to the facility could trigger the requirement to upgrade the structure, which is not economically feasible to accomplish.

Please see the attached Consulting Engineers Reports for more detailed analyses of the buildings structural, mechanical, electrical, and life-safety systems.

Building Codes:

While existing buildings are generally "grandfathered" by many codes, and therefore not required to be constantly altered or improved to maintain full code compliance, any significant alteration of the facility would trigger requirements for updating systems to meet current codes. Per the NH Department of Education's Minimum Standards for Public Schools (Ed 321.27) if a renovation exceeds 60% of the cost for new construction, "*The scope of the renovation project shall provide that all building systems shall be upgraded to the most current codes and standards and that the building shall be fully accessible to individuals with disabilities."*

A number of areas of non-compliance with the Life Safety Code have been observed. These include corridor width and means of egress from select spaces such as the courtyard.

As noted above, there are numerous areas of non-compliance in mechanical, electrical and life-safety systems. Among those noted in the Consultant Engineers Reports, perhaps the most significant is ventilation, with many areas of the building significantly under-ventilated resulting in indoor air quality issues, which can directly impact staff and student performance.

Compliance with the Americans with Disabilities Act is a requirement of any new, or renovated educational facility. The lack of accessibility throughout the building is readily evident. The toilet rooms are non-compliant and will require extensive reconstruction to achieve compliance. Many building systems, such as signage, controls, fire alarm signals, etc, do not meet the requirements of the ADAAG. Upgrades or replacements of these systems and components will likely be required if the District elects to renovate or expand this facility.

Functional Requirements:

A fundamental question in the assessment of any facility is whether or not it supports its intended use.

Particularly in educational buildings, constantly changing program and curriculum requirements render a building increasingly inefficient and sometimes ineffective in meeting the educational mission. The goals of an education system and the means of achieving those goals should, within reason, not be limited by the building which houses those functions. This building has not been altered or upgraded to keep pace with the need of contemporary middle school educational programs.

The "core areas", including the media center, the cafeteria, the gymnasium, and the administration areas, are undersized for a current student population of approximately 1100+ students. There is a measurable shortage in office areas to accommodate staff both in administration and faculty areas. While it appears that faculty and staff have made the best use of their respective areas, it is clear that more space is necessary to provide a productive work environment.

Another increasingly important issue in contemporary middle school design is building security. The current building has several non-securable entrances with many areas that provide limited opportunity for staff to effectively supervise the students between classes. Current school planning allows for effective monitoring of both access to the school and of the many occupied spaces within the school. The narrow, long, and turning network of corridors, have created a facility with limited control points for supervision. Current school design practices provide for a secure environment through both access control and supervision.

Many of the academic areas of the facility are undersized by NH Department of Education standards, which, must be noted, are typically less than generally accepted standards used throughout the country. Based on preliminary calculations, the core areas of the building are sized for a student population of approximately 700 students and the educational areas are sized for a maximum student population of approximately 740 students. In addition to the overall size limitation of the facility, many of the individual spaces are undersized. Most classrooms do not have recommended 900 square feet of space or proper daylighting for a quality school environment. Per NH DOE's minimum allowable standards, the science labs in this building cannot support more than 17 students per class, yet due to lack of science lab space, currently house 24 students per class.

Support spaces for faculty and guidance are not adequate. There are no designated team meeting spaces, therefore making it difficult for teachers to work collectively and cooperatively. With a student population exceeding the building calculated capacity, the space utilization rates exceed recommendations, further challenging faculty and staff to efficiently perform their assigned duties.

The classroom layout does not reflect current planning practices and does not support a progressive middle school educational program. Team teaching practices, including classroom grouping strategies to provide supportive networks and collaborative teaching models, cannot be accommodated within the building. Small group instruction is not feasible due to lack of space. Space and organization limitations in this building will continue to challenge sound educational practices as well as limit curricular advancements.

Summary:
Based upon our tour of the facility and a preliminary review of the information available to us, our professional assessment of this building is that it does not provide an adequate environment for a 21st century middle school education. Our assessment is further reinforced by the findings of the New England School Development Council, detailed in their report being produced concurrently with this report. The NESDEC report notes more than 30 needs and deficiencies. The NESDEC findings go on to state that the middle school building is "unable to fully implement 21st Century educational programs."

While the faculty and administration can be commended on their efforts to provide a quality middle school educational program, the building increasingly challenges those efforts, resulting in inefficient use of staff resources and unnecessary limitation of full achievement of educational initiatives.

As the District and the community consider the future of this building, they should be aware of many issues that may arise under a renovation scenario. Many of the deficiencies noted above (such as corridors that are too narrow, limited security and supervision challenges, substandard classroom sizes, lack of ADA compliance, inability to upgrade to meet seismic codes) are simply not feasible to remedy through renovation. Nearly all of the issues listed under the Functional Requirements assessment above are not addressable at reasonable cost via a renovation of, or addition to, the building. Per the NH DOE guidelines, if the Timberlane Middle School were to be renovated, the project must not exceed 60% of the cost of new construction, or it would be required to meet current codes. Given our findings, we believe that this building cannot readily, or cost effectively, be brought within compliance with current codes and planning standards.

Since options for renovations or expansion are not practical or cost-effective, we recommend the School District consider replacement of the middle school.

Timberlane Regional High School

Building Condition

The building was originally built in 1966 and has undergone three additions (1980, 1987, and 2000), totaling 167,840 sf. The efforts of the Maintenance Staff to maintain and upgrade the facility on an annual basis are evident. The interior spaces are clean and well maintained. The envelope of the facility includes a recently replaced roof membrane, but includes exterior wall systems that are aged and failing. The upper portions of the exterior wall are in need of masonry repair and are contributing to moisture penetration and energy inefficiency. The exterior walls are approximately 50% glass and panel curtainwall systems. These curtainwall frames are not thermally broken and remain largely single glazed. Overall, the envelope is substandard, contributing to energy loss and unnecessary long term utility costs.

The areas renovated in 2000 consist of a finished cement panel system, which has proven to be an annual maintenance issue. These panels are already in need of re-sealing and repair and will continue to require on-going maintenance.

Our assessment of the building infrastructure is a mixed review. The air-handling systems (heating and ventilation) have undergone significant upgrades in the last two years, but do not consistently, throughout the entire facility, meet current energy standards, interior air-quality standards, or acoustic levels.

Electrical and lighting systems have received upgrades in areas of the building, but do not consistently meet current planning and design standards. If this building is renovated or upgraded to continue service as a school facility, wholesale lighting and communications upgrades must be undertaken per the findings of the Electrical Engineer's assessment.

Please see the attached Consultant Engineer Reports for more detailed assessment of structural, mechanical, electrical and life-safety systems.

Building Codes:

While existing buildings are generally "grandfathered" by may codes, and therefore not required to be constantly altered or improved to maintain full code compliance, any significant alteration of the facility would trigger requirements for updating systems to meet current codes. Per the NH Department of Education's Minimum Standards for Public Schools (Ed 321.27) if a renovation exceeds 60% of the cost for new construction, "*The scope of the renovation project shall provide that all building systems shall be upgraded to the most current codes and standards and that the building shall be fully accessible to individuals with disabilities."*

We have observed, similar to our observations of the Middle School, a number of areas of code non-compliance within the High School. Unlike the Middle School however, most of this items of non-compliance are addressable through a program of comprehensive renovation.

One system that cannot, practically, be brought to current code compliance, is the structural system. Required upgrades to bring the structure to compliance for snow load and seismic load are not achievable within reasonable cost parameters. Should a renovation program exceed the 60% cost trigger prescribed by the NH DOE, a waiver for structural code compliance will be required.

Compliance with the Americans with Disabilities Act is a requirement of any new, or renovated educational facility. The lack of accessibility throughout the building is readily evident, though less extensive than those found in the Middle School. Many of the toilet rooms are non-compliant and will require redesign and reconstruction to achieve compliance. Many building systems, such as signage, controls, fire alarm signals, etc, are not compliant with the requirements of the ADAAG uniformly throughout the facility. Upgrades or replacements of these systems and components will likely be required if the District elects to renovate or expand this facility.

Functional Requirements:

A fundamental question in the assessment of any facility is whether or not it supports its intended use.

Particularly in educational buildings, constantly changing program and curriculum requirements render a building increasingly inefficient and sometimes ineffective in meeting the educational mission. The goals of an education system and the means of achieving those goals should, within reason, not be limited by the building which houses those functions.

The "core areas", including the media center, the cafeteria, the gymnasium, and the administration areas, are undersized for the current student population of approximately 1500+ students. Administration, Faculty, and Guidance departments are in need of additional space to operate efficiently. Faculty work areas and team meeting areas are typically undersized and not well distributed within the building. More space for each of these departments (particularly guidance) would give students more access to school staff and enable better student support.

Many of the academic areas of the facility are undersized by NH Department of Education standards, which, must be noted, are typically less than generally accepted standards used throughout the country. Based on preliminary calculations, the core areas of the building are sized for a student population of approximately 830 students and the educational areas are sized for a maximum student population of approximately 1100 students. In addition to the overall size limitations of the facility, many of the individual spaces are undersized. Most science labs do not have the required 1440 sf of space for a science class size of 24 students (per NH DOE Code of Administrative Rules ed 321).

The classroom layouts further challenge administration and faculty as they work to implement a progressive High School education program. Team teaching practices, including classroom grouping strategies to provide interdisciplinary shared teaching, cannot be effectively accommodated within the building. While there are some adjoining classrooms, they are not integrated into the various High School departments. Small group instruction, often needed for advanced placement courses, cannot be accommodated easily within the building simply due to lack of space. Space and organization limitations in this building will continue to challenge sound educational practices as well as limit curriculum advancement.

Another increasingly important issue in contemporary high school design is building security. The current building has several non-securable entrances with many areas that provide limited opportunity for staff to effectively supervise the students between classes. Current school planning allows for effective monitoring of both access to the school and of the many occupied spaces within the school. The meandering network of corridors, including more than six long main classroom corridors, creates a difficult environment to visually supervise. Current school design practices provide for secure environment through both access control and supervision. A renovation of this facility will likely utilize video surveillance systems, as well as redistribution of faculty/staff work areas, to address these security issues.

Summary:

Based on our tour of the facility and a summary review of the information available to us, our professional assessment of this building is that it is in need of significant improvements and additions in order to create an environment supportive of a student population of 1500, and a 21st century high school curriculum. Our assessment is further reinforced by assessment from the New England School Development Council (NESDEC), being produced in parallel with this assessment. Within this report, NESDEC noted more than 35 needs and deficiencies of the high school facility. Based on the report of NESDEC, this building has a planned operating capacity of 952 students in classrooms, and far less in core spaces such as the media center and the cafeteria. The NESDEC report simply states that the Timberlane Regional High School is "in need of major renovations and reconfigurations."

While the building can obviously be considered a valuable asset to the District, it remains to be determined if upgrades and additions can bring this building up to the standards of new high school planning and construction, and whether those upgrades and additions will be a long-term cost-effective solution. More detailed design studies must first be developed to determine whether this building should be renovated into a progressive high school or whether a new high school facility should be considered, allowing this building to be renovated into an enlarged and effective middle school. We, at Lavallee Brensinger Architects, reserve our final recommendations for this facility until design studies can be completed and costs assessed. A review of the various options must include not only the School District and it's taxpayers, but also all authorities having jurisdiction, including the State Fire Marshall's Office and the NH Department of Education, to ensure that the building is safe and also eligible for State Building Aid.

Sincerely,

Lance Whitehead, Project Manager
Lavallee/Brensinger Architects

Fred Urtz, AIA, President
Lavallee/Brensinger Architects

Lavallee Brensinger ARCHITECTS

Timberlane Regional Middle School and Timberlane Regional High School
Existing Conditions Assessments

- Consulting Engineer's Reports

  -Structural Engineer's Reports

  -Electrical Engineer's Report

  -Mechanical Engineer's Report

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Preliminary Structural Assessment
of

Timberlane Regional Middle School
S.A.U. #55
Plaistow, NH

prepared by
Foley Buhl Roberts & Associates, Inc.
October 2008

This report was prepared by Foley Buhl Roberts & Associates (FBRA), Structural Engineers, in cooperation with Lavallee/Brensinger Architects (LBA). This report is intended to provide a description and assessment of the structural systems and structural condition of the existing middle school building, for the use of School Administrative Unit 55 in planning future educational space requirements.

This report is based upon:

- Review of the 1998 document entitled "SAU #55 District Wide Capital Improvements Plan".
- Review of the structural construction drawings for the classroom wing constructed in 2000 (gable roof wing at the southeast corner of the school complex.
- Review of the requirements of the International Building Code 2006 applicable to building additions.
- An on-site meeting with Lavallee Brensinger Architects and other engineering consultants, held at the school on September 19, 2008.
- A two-hour walk-through of the building, intended to confirm structural system types and to assess the condition of the building.
- Discussions with Jim Hughes (SAU #55) regarding the past maintenance history of the building.

Description

The school is an assemblage of one-story buildings of varying vintages. The major eras of construction are identified in the 1998 planning document as:

- 1975 - Original school, 72,600 square feet.
- 1984 - Addition housing music and boiler room, gym expansion, 11, 050 square. ft.
- 1996 - Classroom addition, south side of original building, 25,800 square ft.
- 2000 - Classroom addition of southeast corner of school, 9,000 square ft.

No original construction documents were available for the 1975, 1984 and 1996 eras of construction. Accordingly, no information is available with regard to the building foundations or floor slab construction in these areas. However we observed no evidence of structural issues that would be related to foundation or slab performance in the course of our on-site review of the school.

All areas of the building utilize open web steel roof joists. Complete information on the joist series and chord size was available only for the 2000 addition. In the absence of the original construction drawings, identification of the joists used in the older sections of the building with sufficient accuracy to make a load capacity analysis is an exercise that would require several days on site to collect the necessary field measurements. This work is beyond the scope of the two hour on-site walk through conducted for this condition assessment. Our evaluation of structural adequacy for the older sections of this school presented in this report is therefore qualitative. Our opinions are based primarily on our field observations and our experience with similar structures.

Total floor area for the entire school is approximately 118,500 square feet. All sections of the school are one story with the exception of the mechanical catwalk in the 2000 addition. The floors in all areas are believed to be grade-supported slabs. The floor elevation in the 1996 and 2000 additions is approximately 16 inches above the floors in the earlier areas of construction. This transition in elevation is handled by ramps in the school corridors.

The roof heights vary depending on the era of construction and the use of the space, with the higher roofs generally being associated with the larger assembly spaces. The highest roof areas and the major roof height transitions are associated with the gym and the 1984 addition.

1975 Original Building

The main low roof of the original 1975 school has very flat, low pitch (approximately 1V:12H) gable roof, drained by sheet flow over the eave lines. This roof comprises the largest portion of the school. The roofing in this area is a relatively new EPDM single ply membrane, reportedly installed over (added) rigid insulation. The structural roof deck, visible from below, is a cement fiber panel product (“Insulrock” or “Tectum”, or similar) manufactured with a cold-formed steel perimeter channel frame and installed in a random deck layup. (This structural deck is essentially identical to the roof deck used in the original High School building). We did not observe any areas of damaged or deteriorated roof deck during the course of our walk-through.

The roof deck is supported on open web steel joists, with the joist size and depth varying depending on span conditions. Typical joist spacings are 3 to 4 feet on centers. Given their appearance, age and configuration FBRA believes these are Steel Joist Institute “J” series joists, similar to those used in the original High School building.

The roof joists in this low roof area are supported on structural steel framing lines. Typically these beams are running north-south, with the steel beams sloped to produce the gable roof pitch. The bay size is variable. Columns are frequently visible on both sides of the corridors. The maximum bay size (visible in the school library) is 30’ x 30’. The steel beam lines are supported on structural steel columns. These are W5 and W6 steel shapes and they are frequently exposed to view throughout the building. These columns seem small given the tributary roof area. In our estimation, the overall capacity of the roof is probably limited by 1.) the cement fiber decking, 2.) the open web joists and 3.)

the columns, in that order, but the numbers are probably very close for all three of these components. Qualitatively, we anticipate that the roof structure has a uniform snow load capacity very comparable to the nearby High School, probably in the 42 to 50 pounds per square foot range. This capacity compares favorably with current flat roof snow load Code requirement of 42 psf for the Plaistow area, using a 1.1 importance factor. As previously noted, more extensive field measurements and identification of typical joists would be necessary to quantify and corroborate this opinion.

This original school was designed and constructed just as requirements for snow drift considerations were being incorporated into the model building Codes. Potential snow drift areas do occur on this roof, on the low roof areas adjacent to the gymnasium. We saw no evidence that these roof areas had been reinforced to address potential snow drift areas. This is typical for buildings constructed prior to the mid 1970s.

The building's columns are frequently built into non-load bearing CMU partition walls. These walls do not extend up to meet the roof structure. The column flanges are in most cases exposed to view, with the flanges outside the plane of the adjacent masonry wall surface. In our opinion, the masonry partitions do offer some additional lateral support for the column, thereby increasing its load capacity. However not all of the columns in the building are built into masonry walls; some columns are free-standing.

The building's steel frame has no defined lateral load resisting system (in particular, no steel bracing). However, the non-load bearing partitions do offer some very limited resistance to wind and seismic loading, although the contribution is not quantifiable.

The original gym was part of the 1975 construction. The gym was subsequently enlarged by an addition that extended the east end of the gym approximately 50 feet. This addition appears to have been added as a part of the 1984 building program. Both sections of the gym have a common flat roof elevation, internal roof drains and relatively new EPDM roofing. The original portion of the gym has a cement fiber roof deck, similar to the low roof areas of the 1975 building. The newer east end has a cold-formed steel roof deck. Both sections of the gym are framed with open web steel joists, spanning in an east-west direction. A large rolled steel "I" girder clear spans the gym at the interface between the original and later construction. This girder carries supports the roof joists (new and old) on both sides. Because the later addition was smaller than the original gym, this girder is not symmetrically located at the center of the gym. As a result the net divider used to separate the gym into two spaces is suspended from an intermediate point on the original roof joists. FBRA recommends further evaluation of this entire roof structure to review all of the applied loads, including snow, mechanical equipment, backboards and the net divider.

1984 Addition

This is a low, flat roof addition south of the gymnasium that includes the boiler room as well as two large music rooms. This section has a stone ballasted roofing membrane over rigid insulation, The roof deck is 1.5" deep wide rib cold formed steel deck, supported on open web steel joists spaced at 5'-0" on centers. The joists are supported on concrete masonry bearing walls. Typical elements of this construction can be viewed directly from the boiler room.

1996 Addition

This is a low, flat roof classroom addition that now forms the south side of the school complex. It is separated from the original 1975 building by a large center courtyard.

The roofing in this area is a single ply EPDM membrane. The roof is drained by interior roof drains. The roof has very slight roof drainage pitch (approximately 1/8" per foot). The roofing is applied over rigid insulation. The structural deck is a 1.5" deep, wide rib, cold-formed steel deck, supported on open web steel joists. The joists are supported on load-bearing masonry walls at the corridor sidewalls and the exterior walls.

Generally, the structural condition of this addition appears to be very good, and the structural components used in its construction are more robust than in the other areas we reviewed.

2000 Addition

This is a double-loaded center corridor addition extending eastward from the southeast corner of the school. It is very similar in construction to the 2000 addition at the neighboring high school, differing only in that the Middle School addition utilizes a different type of roofing membrane.

This addition has a low pitch 2.5V:12H gable roof with single ply EPDM membrane roofing over rigid insulation. The roof deck is a 1.5" deep, wide rib cold-formed acoustic steel deck. This deck features perforated webs and sound absorbing batts in the deck flutes. The classrooms have no ceilings and accordingly the roof deck and supporting structure are exposed to view. The roof deck is supported on sloped open web steel joists (typically 22K6 joists spaced at 4'-5-1/4" in the classrooms).

The roof joists are supported on structural steel braced frames, comprised of rolled steel wide-flange beams and HSS tubular columns. These framing lines are arranged on either side of the center corridor and also along the eave lines at the exterior walls.

The roof also features one skylight per classroom. The skylights are installed between the roof joists.

There is a mechanical catwalk (or mezzanine) located over the center corridor. This mechanical space has a steel form deck floor and gable-pitched roof joists. The catwalk is accessed from a stairway at the east end of the building.

Observations and Commentary

Cement fiber roof decks have generally fallen out of favor with the building industry. These products have a history of deterioration where the product has been subjected to repeated wetting, typically caused by roof leaks. Usually, deteriorated panels are apparent due to the discoloration caused by the leaks. In the course of our walk-through, we spot-examined the underside of the roof deck in a several areas. We noted damaged roof decking panels in the older section of the gymnasium, but elsewhere in the original building the roof deck appears to be in good condition.

Cement fiber decks are intended for roof construction and are not utilized for floors. These products are not suitable for concentrated or impact loads. Typical design load capacities for a 3" thickness on a 4 foot span are approximately 50 pounds per square foot.

Since 1975, model building codes have included consideration for snow drift loads. The original 1975 construction apparently pre-dates that requirement. Typically, drifts are anticipated on lower roofs where they are adjacent to higher sections of the building. It does not appear that the low roof areas of the building adjacent to the gymnasium were designed with consideration for drift loads.

If it were designed today, potential drift areas would be required to support snow drift loads of up to three times the minimum flat roof snow load. However the building is presently "grandfathered" into a code-compliant status with respect to this requirement. FBRA believes it is important for the SAU and maintenance personnel to understand this situation and to have a plan in effect to monitor these areas of the roof for drifted snow and, if necessary, to remove accumulated snow drifts from these areas.

The steel columns used in the original 1975 construction are relatively small given their height and tributary roof areas. Typically, columns are somewhat more conservatively sized and it is unusual to find a building where the column size is the limiting factor (or close to the limiting factor) as far as structural capacity. The reason for this is that a flexural member such as a beam or joist will deflect noticeably prior to reaching its ultimate load capacity. This usually provides ample warning of an overload situation. Columns, on the other hand, typically fail in a sudden, buckling mode, without advance warning. For this reason, Code safety factors are generally more conservative with respect to columns, and most building designers elect to be more conservative when sizing columns as opposed to flexural members.

The masonry partitions of the 1975 building do afford the building some ability to resist wind and seismic loads. However this ability is limited by several factors, including the (probable, assumed) absence of reinforcing in the masonry walls, the (apparent) absence of masonry anchors to connect the walls to the columns, and the partial height nature of these walls.

Both the 1984 and 1996 additions utilize very common structural components and widely used structural systems. We were not able to determine how or if the masonry bearing walls in these sections are reinforced. However, both of these areas appear to be in good condition and we did not observe any apparent structural concerns or issues in either area.

The 2000 classroom addition is a relatively new steel frame structure. On the basis of our field visit, we saw no apparent structural issues with this addition. FBRA has also reviewed the original construction drawings for this addition. While the overall building reflects the unusual priorities and design principals of the firm that designed it, the structural systems are conventional and well executed. FBRA suggests that the SAU may want to consider installation of a more suitable flooring material over the form deck catwalk in the mechanical mezzanine.

FBRA recommends an architectural review of the corridor ramps that connect the original school to the 1996 addition. These ramps may exceed the 1 on 12 slope, 30' maximum length requirements recommended by ADA standards.

We did not observe any damage or conditions that would be associated with foundation problems or settlement anywhere in this school.

Expansion Potential

The existing structural systems are not amenable to adding additional floors. The major obstacles include the following issues:

- The existing cement fiber roof deck of the original 1975 school is not suitable for use as a floor.
- The existing roof joists in all areas of the school do not have sufficient load capacity to carry floor loads. Strengthening these joists is not a practical solution.
- Both the original 1975 building and the 2000 addition have pitched gable roof framing that cannot be adapted to support a floor. These two areas constitute more than 60% of the building footprint.
- The 1975 building has no fully functional lateral load-resisting system. Additional stories would substantially increase both wind and seismic forces, requiring a full seismic retrofit at the first floor level.
- No information exists that would allow us to assess the ability of the existing foundations of the 1975, 1984 or 1996 additions with regard to their ability to carry the loads imposed by a vertical expansion.
- The columns of the 1975 building do not have any significant reserve load capacity that might be utilized for vertical expansion.
- Given the dates of construction, the existing load-bearing concrete masonry walls in the 1984 and 1996 additions may not be reinforced to the level that would make them code-compliant for a multi-story structure. Determination or verification of the existing reinforcement levels can only be made via exploratory demolition of selected wall sections. The requirements for wall reinforcement under the current building code are a function of the building's Seismic Design Category (SDC). Determination of the SDC for this building would require site geotechnical information that is presently not available. If the SDC classification of the building is "D" or higher, the walls would likely require additional reinforcement (or wholesale replacement) if an additional floor were added. Reinforcement or replacement of these walls is not a practical solution.

Accordingly, FBRA advises the school administration that the potential for cost-effective vertical expansion of this building is poor.

The site restrictions surrounding this building include Greenough Road and the school parking areas to the northwest, the Performing Arts building to the northeast, athletic fields to the southeast. Any potential future building additions would likely be limited to the southeast (rear) side or the wooded area southwest of the existing school.

Code Issues

The building is generally in good condition and has been well maintained. The current structural repair needs are minor. Structural upgrades are not mandatory and the building remains code-compliant in a "grandfathered" status, provided that the existing structure is not extensively modified.

As noted previously, FBRA does recommend further review and analysis of all loads imposed on the gym roof structure.

With certain restrictions, the State Building Code (IBC 2006) would permit renovation of the building without requiring upgrading the building structure to meet the current Code structural loading requirements applicable to new construction. The principal Building Code restriction to this renovation approach is that the final renovated conditions do not result in a net reduction in the building's capacity to resist applied loads.

However, New Hampshire Department of Education standards are more stringent. DOE standards would require full compliance with the structural design loading requirements for new construction if the expenditures for renovation of the building meet or exceed 60% of the replacement cost for the building.

FBRA understands that the School District may be interested in voluntarily making the building fully Code-compliant with respect to the structural loading standards applicable to new construction, regardless of the anticipated costs associated with renovation.

The 1975 building that comprises the majority of the school predates Building Code requirements for seismic design and snow drift loads. Additionally, the structure does not meet current standards for wind uplift loads on the roof. While upgrades to meet current Code loading requirements are possible, they would involve major and extensive changes to the building structure. This work would in some cases require removal and replacement of other building systems in order to complete the structural upgrades. The potential for this kind of structural upgrade at the Middle School is similar to the situation at the High School, except that the Middle School has only one major elevation change (occurring adjacent to the gym) to cause potential snow drift conditions. The original 1975 portion of the Middle School has a primary structural steel frame (as opposed to the load-bearing masonry walls of the High School).

For example, if a roof structural diaphragm is required to address seismic concerns, then replacement of the cement fiber roof decks would be indicated. This in turn would necessitate replacement of the roofing membrane and insulation. Where additional roof joists are required to address snow drift concerns, the installation of these new joists will necessitate replacement of ceilings, lighting and other building systems that now exist within the plane of the roof framing.

Retrofitting the original 1975 steel frame structure to address current seismic load design criteria would most efficiently be accomplished by introducing steel bracing bays. This work would also require reinforcement of the existing columns and beams in the bays receiving the new bracing. Identifying the framing bays to be braced in this manner would involve compromises between selecting bays on the basis of structural efficacy versus the architectural impacts of adding these braces.

If a small number of braced bays are introduced, seismic design forces will result in uplift of the existing foundations. This situation would necessitate construction of new, heavier foundations at the braced bay locations.

On the other hand, if a larger number of bracing bays are introduced, new foundations might be avoided, but the architectural restrictions on the use of building space resulting from introduction of the braced bays will be increased.

In short, these upgrades may be technically possible, but they may not be a practical or economically feasible solution compared to the cost (and other advantages) of a new building.

This concludes our preliminary structural assessment of Timberlane Regional MIddle School. Please contact us if we can provide further clarification of any of the issues discussed in this report.

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Preliminary Structural Assessment
of

Timberlane Regional High School
S.A.U. #55
Plaistow, NH

prepared by
Foley Buhl Roberts & Associates, Inc.
October 2008

This report was prepared by Foley Buhl Roberts & Associates (FBRA), Structural Engineers, in cooperation with Lavallee/Brensinger Architects (LBA). This report is intended to provide a description and assessment of the structural systems and structural condition of the existing high school building, for the use of School Administrative Unit 55 in planning future educational space requirements.

This report is based upon:

- Review of the 1998 document entitled “District Wide Capital Improvements Plan”.

- Review of the structural construction drawings for the renovations done in 2000. These plans do contain some limited information regarding the structural systems used for the original 1996 building and the 1987 addition.

- Review of the structural construction drawings for the “Area E” classroom wing constructed in 2000.

- Spot review and load capacity analysis of typical joist sizes used in the existing roof structure.

- Review of the requirements of the International Building Code 2006 applicable to building additions.

- An on-site meeting with Lavallee Brensinger Architects and other engineering consultants, held at the school on September 19, 2008.

- A two-hour walk-through of the building, intended to confirm structural system types and to assess the condition of the building.

- Discussions with Jim Hughes (SAU #55) regarding the past maintenance history of the building.

Description

The school is an assemblage of one-story buildings of varying vintages. The drawing set developed for the expansion and renovations done in 2000 divides the school into six areas, identified by letter as A through F. The major eras of construction are identified as:

- 1966 - Areas A, B, C and D, original school, 106,000 square feet.
- 1987 – Area F Wrestling room and related athletic support areas, 10,000 sq. ft.
- 2000 - General renovation of areas A thru D, including, east side expansion of areas B and D involving the gym and cafeteria; 6,000 sq. ft.
- 2000 - Area E classroom addition at rear (south) of original school, approximately 40,000 square feet.

Total floor area for the entire school is approximately 166,000 square feet. All sections of the school are one story with the exception of the mechanical catwalk in the Area E addition. The majority of the school has 4" thick grade-supported floor slabs, the exception to this being a framed slab supported on grade beams throughout most of Area C. The reasons why a framed floor system was utilized for Area C are not evident. All floor slabs are at the same elevation throughout the building.

Roof elevations vary. Excepting the sloped roof areas of the 2000 Area E classroom addition, the remainder of the building has a flat roof with interior drains. The lowest roof areas comprise the majority of the building footprint. These include the corridors, most of the original classrooms and the office area.

There are a number of higher roof levels. These high roofs are associated most often with the larger assembly spaces. These include the gymnasium, cafeteria, library (two levels), industrial arts area and the north-central portion of the Area C classroom wing. The roof height differentials (change in elevation relative to the main roof) range from approximately +14 feet at the gymnasium to +4 feet at the Area C classrooms.

1966 Original Building

The original 1966 building (Areas A, B, C and D) was re-roofed with a single ply EPDM membrane in 2007. According to Jim Hughes, the gravel was removed from the original tar and gravel roofing system, 3 inches of rigid insulation were added over the original roofing, and the EPDM membrane was installed over the new insulation. Drainage pitch in these areas is relatively low, approximately 1/8" per foot or less.

The yellow roof decking panels used throughout the original 1966 school are a cement fiber product, supplied here with a metal frame around each panel. There have been several vendors of cement fiber decking products of this nature, and these panels may be "Insulrock" or a similar product such as "Tectum" or "Fibrodeck". Although the specific manufacturer could not be identified, all of these products have similar characteristics. These panels are often overlaid with a variable depth, cast-in-place gypsum fill. We were not able to verify the existence of a gypsum fill overlay on this roof deck.

The roof decking in the original school is supported on "J" or "LA" series open web steel joists, with the joist depths ranging from 10" to 48", depending on span lengths. The roof joists are typically spaced at 3'-0" to 4'-0" on centers. The majority of the roof joists bear directly on masonry walls, with rolled structural steel beams used to span wall openings.

The load-bearing masonry walls of the original school are predominately composed of concrete masonry units, although brick masonry is used in conjunction with the concrete block in many areas. Our inspection verified the use of horizontal joint reinforcement in those areas where an exterior brick veneer is present. We were unable to ascertain whether or not the load-bearing walls contain any vertical steel reinforcement. However we anticipate that these walls are most likely not vertically reinforced, since reinforcement of a single story wall of this sort would be unusual given the vintage and also because the frequent use of brick on top of CMU would have complicated construction of a reinforced wall section.

The original building has no defined lateral load resisting system, but there are a number of long, load-bearing interior walls that are capable of providing significant resistance to wind or seismic loads.

1987 Addition

The 1987 athletic addition has its original stone ballasted membrane roofing installed over rigid insulation and a 1.5" deep steel roof deck. The roof framing in this addition is predominately open web steel joists, supported on load-bearing masonry walls. Lateral load resistance is provided by the perimeter masonry walls acting as shear walls.

2000 Addition

The 2000 classroom addition has a 2.5:12 pitch gable roof with a TPO single ply roofing membrane (white) installed over rigid insulation, supported on 1.5" deep acoustic steel roof deck. The roof deck and open web joist framing are exposed to view in the classrooms of this addition. The roof joists are supported on structural steel framing lines that extend along the exterior walls and the corridor walls. Lateral load resistance is provided by structural steel braced frames.

Exterior wall finishes are typically comprised of a 4" brick veneer in the high bay areas of the original school. The newer additions typically utilize a stucco finish on a cement fiberboard backing (similar to an EIFS system).

Observations and Commentary

Cement fiber roof decks have generally fallen out of favor with the building industry. These products have a history of deterioration where the product has been subjected to repeated wetting, typically caused by roof leaks. Usually, deteriorated panels are apparent due to the discoloration caused by the leaks. In the course of our walk-through, we spot-examined the underside of the roof deck in a several areas. We noted damaged roof decking panels in the older section of the gymnasium, but elsewhere in the original building the roof deck appears to be in good condition.

Cement fiber decks are intended for roof construction and are not utilized for floors. These products are not suitable for concentrated or impact loads. Typical design load capacities for a 3" thickness on a 4 foot span are approximately 50 pounds per square foot.

The sizes of the open web steel roof joists used throughout the original school were frequently noted on the 2000 drawings when the joists were at or near renovated areas. This implies that the original structural drawings for the school were available at the time those drawings were prepared. The sized enumerated on those drawings generally matched the size, type, span and spacing observed during our walk-through, with the exception of the gymnasium. On the basis of our site observations and analysis, FBRA believes the joist size shown for the original gym roof (48LA11) is incorrect and was probably transcribed from the nearby cafeteria. Unfortunately, the original structural drawings were not available for this assessment.

FBRA has subsequently analyzed several different roof areas and concluded that the roof has a uniform snow load capacity of 42 to 56 pounds per square foot (psf), varying with location, joist size and span. This uniform snow load capacity compares relatively well with the current State Building Code requirement for Plaistow of 42 psf (this figure is based on “Ground Snow Loads for New Hampshire” appendix to IBC 2006 and ANSI/ASCE 7, developed using an importance factor of 1.1)

Since 1975, model building codes have included consideration for snow drift loads. The original 1966 construction pre-dates that requirement. Typically, drifts are anticipated on lower roofs where they are adjacent to higher sections of the building. This building does have a large number of roof elevation changes. If it were designed today, those potential drift areas would be required to support snow drift loads of up to three times the minimum flat roof snow load. However the building is presently “grandfathered” into a code-compliant status with respect to this requirement. FBRA believes it is important for the SAU and maintenance personnel to understand this situation and to have a contingency plan in effect to monitor these areas of the roof for drifted snow and, if necessary, to remove accumulated snow drifts from these areas.

As noted previously, the original gravel roofing ballast has been removed from virtually all of the original 1966 building and replaced with a single ply EPDM membrane. The new EPDM membrane does not require gravel ballast. As a result, the dead load of the roofing system has been reduced by an estimated 5 to 6 pounds per square foot. This change results in a modest increase in the gravity (snow) load capacity of the roof structure. In this case, this load capacity benefit is somewhat offset by the 3 inches of additional insulation that was installed beneath the new roofing. However, the reduction in dead load associated with this roofing change may make the roof structure more vulnerable to wind uplift loads. The roof joists in the original building do not have wind uplift bridging. If necessary, this issue can be addressed by installation of additional lines of bottom chord bridging on the roof joists.

The original 1966 building utilizes what are believed to be unreinforced masonry bearing walls. This type of construction is typical of school buildings of this vintage. However, the current state building code would require that new masonry wall construction contain minimum levels of reinforcement. This reinforcing requirement would apply retroactively to the existing walls if the building were to be expanded vertically. Adding reinforcement to the existing masonry walls is not a practical solution. This consideration, taken together with the cement fiber roof deck construction, effectively precludes vertical expansion of the building (i.e., adding a second floor).

We observed some loss of mortar from the brick veneer surrounding the gymnasium, particularly on the west elevation. Jim Hughes reports that the stucco finished cement board exterior wall surfaces have proven to be maintenance intensive, particularly along the additions to the east side of the original building.

The 1987 addition has several unique problems. The exterior faces of the masonry walls of the wrestling and weight rooms are apparently not well sealed against moisture penetration. The result has been extensive peeling and flaking of the interior-side paint. FBRA believes these CMU walls were insulated with either core inserts or vermiculite fill, but these spaces are reported to be cold and additional insulation is needed. Finally, cantilever basketball backboards were installed on opposing walls of the wrestling room. Players hanging on the rims of these backboards can exert large unanticipated bending stresses in the masonry walls. The crack patterns developing in these walls indicate that this is what has occurred in this instance. FBRA recommends that these backboards be removed.

We did not observe any damage or conditions that would be associated with foundation problems or settlement.

Expansion Potential

The existing structural systems are not amenable to adding additional floors. The major obstacles include the following issues:

- The existing cement fiber roof deck is not suitable for use as a floor.
- The existing roof joists do not have sufficient load capacity to carry floor loads. Strengthening these joists is not a practical solution.
- The existing load-bearing concrete masonry walls are thought to be unreinforced masonry. Current building code requirements for this area and use group would require reinforcement or replacement of these existing walls if an additional floor(s) were added. Reinforcement or replacement of these walls is not a practical or economically defensible solution.

Accordingly, FBRA advises the school administration that the potential for cost-effective vertical expansion of this building is poor.

The site restrictions surrounding this building include Greenough Road and the school parking areas to the northwest, the Performing Arts building to the southwest, athletic fields to the southeast and parking and athletic fields to the northeast. Any potential future building additions would likely be limited to the southeast (rear) and northeast sides of the existing school.

Code Issues

The building is generally in good condition and has been well maintained. The current structural repair needs are minor. Structural upgrades are not mandatory and the building remains code-compliant in a “grandfathered” status, provided that the existing structure is not extensively modified. However, code compliant by virtue of its “grandfathered” status does not mean that the building structure complies with the Code requirements for new construction.

With certain restrictions, the State Building Code (IBC 2006) would permit renovation of the building without requiring upgrading the building structure to meet the current Code structural loading requirements applicable to new construction. The principal Building Code restriction to this renovation approach is that the final renovated conditions do not result in a net reduction in the building's capacity to resist applied loads.

However, New Hampshire Department of Education standards are more stringent. DOE standards would require full compliance with the structural design loading requirements for new construction if the expenditures for renovation of the building meet or exceed 60% of the replacement cost for the building.

FBRA understands that the School District may be interested in the feasibility of making the building fully Code-compliant with respect to the structural loading standards applicable to new construction, regardless of the anticipated costs associated with renovation.

The 1966 building that comprises the majority of the school predates Building Code requirements for seismic design and snow drift loads. Additionally, the structure does not meet current standards for wind uplift loads on the roof. While upgrades to meet current Code loading requirements are possible, they would involve major and extensive changes to the building structure. This work would in some cases require removal and replacement of other building systems in order to complete the structural upgrades.

For example, if a roof structural diaphragm is required to address seismic concerns, then replacement of the cement fiber roof decks would be indicated. This in turn would necessitate replacement of the roofing membrane and insulation. If additional roof joists are required to address snow drift concerns, the installation of these new joists will necessitate replacement of ceilings, lighting and other building systems that now exist within the plane of the roof framing. Seismic requirements may necessitate adding vertical reinforcement to existing load-bearing masonry walls, but doing so may not be possible without fully reconstructing the wall. In short, these upgrades may be technically possible, but they may not be a practical or economically feasible solution compared to the cost (and other advantages) of a new building.

This concludes our preliminary structural assessment of Timberlane Regional High School. Please contact us if we can provide further clarification of any of the issues discussed in this report.

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Timberlane School Study: Middle School and High School

Middle School Complex @ 120,000 Gross Square Feet:

Main Electrical Service Infrastructure:

The original school was designed and installed based on an electrical heating program, and with that said, power for the building capacity wise is not an issue. Heating for the building is now fossil fuel driven, which removed the burden from the electrical system, giving what might be consider surplus capacity. The age and condition of the electrical switchgear is at issue. The main electrical service system is anchored by four interior mounted, 15,000 volt sub-stations. This system is made up of one main and three remote sub-station packages, providing transformation and feeder distribution for downstream lighting and power panelboards. This gear was manufactured and installed in 1975 and is near the end of its useful life. This gear can be tested and evaluated for its viability, but will still be over 33 years old, regardless. This electrical gear utilizes and transforms high voltage primary power from the utility and with that carries significant requirements for code required space and working clearances. All four installations at this school reside in non-code compliant spaces. The working clearances in these spaces are unacceptable and dangerous. These packages require a minimum clearance of 6 feet on both sides. We recommend removal and replacement of this switchgear as part of any major renovations and additions to the building. We would recommend a 2000 ampere, 480/277 volt main service entrance switchboard, with replacement switchboards and dry type transformers at each of the three existing sub-station locations. It is recommended that transformation of utility service be installed as outdoor pad mounted equipment, leased from the power company.

Panelboards and General Power:

It appears that nearly every existing panelboard from 33 years ago has been replaced with new. Many of the existing panelboards were part of the free standing sub-stations noted previously, but have been subsequently removed and replaced with new panelboards on adjacent wall spaces. In many cases, panelboards were replaced over existing panelboard back boxes. It appears that generally, panelboards were replaced on a one for one basis. Record drawings indicate that these were installed in either 2000 or 2001. The circuit breaker capacity of these panelboards is good, with spare breaker and load capacity. General power is adequate, yet many spaces would benefit from additional power receptacles and circuits. Overall the panelboards and general power is in good shape and of recent vintage. We see no real upgrades needed here, short of additional panelboards and receptacles required as part of any additions. It is obvious that money has been well spent already upgrading these systems.

General Interior Lighting System:

Lighting at the Middle School is suspect at best. The lighting consists of aged and obsolete recessed and surface mounted fluorescent fixtures. The typical classroom occupancy has three rows of six, 2-lamp, four foot wraparound lens fixtures, with many of those missing or having distressed lens media. The corridors have 2x4, 2-lamp, recessed ceiling mounted, prismatic lens fixtures on approximate 16’ centers. These appear to be in fair shape but at the end of their expected life. Other spaces in the building have a mixture of both, surface mounted wraps or recessed fixtures similar to those mentioned above. The gym lighting is of recent vintage T5HO technology and requires no work. The locker rooms have damp location rated, enclosed fluorescent fixtures, surface mounted on the ceilings, which are distressed and have reached the end of their useful life. Many of the locations have only one local switch to control the lighting in the space. Due to the current Energy Code, any renovations would require a second lighting switch to enable the illumination in the space to be reduced by one half.

It is our understanding that a comprehensive fluorescent ballast and lamp retrofit was performed for Middle and High Schools. This work was performed to save energy and the cost was likely recouped in part by a power company rebate program. The work is ultimately saving energy, by reducing the energy consumed by each light fixture. In almost all cases, the percentage of the energy saved results in reduced light output from the light fixture. This does not appear to be a negative, as the levels of light do not adversely affect the tasks involved. This is a great tradeoff, which allowed the district to simply reuse the existing light fixtures, retrofitted in place.

With the exception of the Gym, and a most recently remodeled Special Education area, we would recommend a complete replacement of the lighting fixtures as part of any major renovations to the building. The lighting technology available today, in consort with the available rebates, makes it a win/win situation for remodeling. Lighting fixtures utilizing HPT8 and T5 lamps, with electronic ballast, are being produced with greater efficiencies and performance. There are many options available to the designer, including recessed and aircraft suspended products. In a Middle School or High School setting, we would recommend a recessed ceiling mounted solution. Lighting controls that would include occupancy sensors, stepped dimming and daylight harvesting should be considered in all areas that compliment those methods. We note that in many of the existing storage or similar occupancy locations, the school is already using spring wound timers or electronic occupancy sensors. In an effort to conserve energy, we would also recommend a comprehensive, automated means to control the overall lighting systems. This can be accomplished with Lighting Control System which would also be used for the exterior lighting as well.

Exterior Lighting Systems:

The exterior lighting systems consists of building mounted product, coupled with utility pole mounted fixtures. The pole mounted product is assumed to be leased from the power company. We would recommend replacing the area lighting with new anchor based pole mounted area lighting for the parking areas, driveways and sidewalks. This would be wired to, and controlled by, the Middle School building electrical systems. Building mounted products and any canopy ceiling mounted lighting should be replaced as well with newer technology.

Emergency Lighting & Exits systems:

Here is an area where recently upgrades took place as part of Life Safety Upgrades. With very few exceptions, we find the emergency lighting and exit sign systems in excellent shape and code compliant. A full review of the placement would need to take place again as part of any major renovations, to augment and reuse product where feasible.

Fire Alarm System:

The Fire Alarm Control Panel is fairly new and of updated addressable technology. The system appears to be a voice/evacuation system with speaker/strobes and strobe only devices. The system is complimented with corridor ceiling mounted smoke detectors as required. The only issue we have with the system is the mounting heights of the Fire Alarm Manual Pull Stations and the wall mounting heights of the strobes and speaker/strobes. The Pull Stations are above ADA required mounting heights at 51″ to the bottom, whereas they should be located at 48″ to the top. The speaker/strobes and strobe only devices are installed at 91″ to the center of the device whereas they should be located at 80″ to the bottom of the device. Coverage of notification and detection appears compliant and adequate. We would recommend lowering the Manual Pulls and Notification devices to the compliant levels as part of any renovations.

School Intercom and Paging Systems:

The school intercom system also functions as a class change system, by sending a tone over the speakers. Classrooms and most occupied spaces have wall mounted call switches. The intercom system switch-bank style console is located in the main office, and has 100 intercom links or switches. The system is as manufactured by Bogen systems, serviced by Williams Communications. We would recommend that the system be replaced with an integrated multi-communication system that allows for keyed handsets in each classroom, with the ability to communicate room to room, and to allow certain types of outside phone calls thru the phone system as required. In most cases, existing wiring and speakers could by reused. Call switches would be replaced with telephone handsets or desksets. A new electronics equipment package and administrative desk-set would replace the existing switch console complete. A Bogen Multicom would be an example of a product suitable for this building.

Telecommunications: Voice and Data:

It appears the structured wiring systems in the building are of recent vintage for both voice and data systems. It also appears that recent technology upgrade projects are helping to keep jack density consistent with traditional requirements. Jack density appears reasonable; to be confirmed by program requirements.

Security And Surveillance:

We observed keypad locations, passive infrared sensors and door contact hardware. This pretty much sums up the security/intrusion system. It appears that the system is operational and of recent vintage. We see no improvements here, short of program required additions, as deemed appropriate in any renovation project

Clock System:

The school presently has a central clock system that is operational in most areas. It appears that as clocks are failing, they are being replaced with battery quartz clocks to save money. System clocks are traditionally expensive to replace or have repaired. We would recommend continuing to replace system clocks with battery powered quartz clocks as existing system clocks fail.

Closing Summary & Comments:

The Middle School has undergone some well needed electrical upgrades including panelboards, fire alarm, data and general receptacle additions. Recent additions and renovations have provided some upgrades to the administration wing and Special Education. The additions and renovations have electrical equipment and wiring that provide wiring consistent with technology available today. With that said, we do not recommend any significant electrical work in those areas. The biggest issues with the Middle School Complex from an electrical standpoint are focused on replacement of the existing medium voltage sub-stations, new interior and exterior lighting, and a new integrated school intercom system.

Engineers Opinion of probable costs: The following opinions of costs are based on current construction costs and our experience with similar project types.

Main Electrical Service Replacement:
Engineers Opinion of probable cost: $580,000 Dollars

Interior Lighting and Controls:
Engineers Opinion of probable cost: $720,000 Dollars

Exterior Lighting and Controls:
Engineers Opinion of probable cost: $ 50,000 Dollars

Fire Alarm System Renovations:
Engineers Opinion of probable cost: $ 20,000 Dollars

Integrated School Intercom System:
Engineers Opinion of probable cost: $390,000 Dollars

Total Electrical Improvement for the Timberlane Regional Middle School:

Engineers Opinion of probable cost: **$1,760,000 Dollars**

High School Complex @ 167,000 Gross Square Feet:

Main Electrical Service Infrastructure:

The main electrical system is anchored by a recently installed 2000 ampere main service entrance system, consisting of a new 2000 ampere main service breaker, which feeds a new main distribution switchboard line-up. Utility power is supplied via a pad mounted transformer, at the back of the present wood shop. The system is 120/208 volt, three phase four wire. With present technology and copper wiring cost, we would typically see a school of this size installed with a higher system voltage of 480/277 volts. To install that type of system now would not be feasible, given the depth of the existing infrastructure. With that said, we would recommend giving consideration to upgrading the system to 3000 amphere. This would be consistent with any planned additions and/or major upgrades to building air conditioning.

Panelboards and General Power:

It appears that nearly every existing panelboard has been replaced with new. In many cases, panelboards were replaced over existing panelboard back boxes. It appears that generally, panelboards were replaced on a one for one basis. Record drawings indicate that these were installed in either 2000 or 2001. The circuit breaker capacity of these panelboards is good, with spare breaker and load capacity. General power is adequate, but many spaces would benefit from additional power receptacles and circuits. Overall the panelboards and general power is in good shape and of recent vintage. We see no real upgrades needed here, short of additional panelboards and receptacles required as part of any additions. It is obvious that money has been well spent already upgrading these systems.

General Interior Lighting System:

Lighting at the High School is similar to that at the Middle School. The lighting consists of aged and obsolete recessed and surface mounted fluorescent fixtures. The typical older classrooms have four rows of 2-lamp, four foot wraparound lens fixtures, with many of those missing or having distressed lens media. The corridors have 2x4, 2-lamp, recessed ceiling mounted, prismatic lens fixtures on approximate 16’ centers. These appear to be in fair shape but at the end of their expected life. Other spaces in the building have a mixture of both, surface mounted wraps or recessed fixtures similar to those mentioned. The gym and wrestling room lighting is of recent vintage T5HO technology and requires no work. The locker rooms have damp location rated, enclosed fluorescent fixtures, surface mounted on the ceilings, which are distressed and have reached the end of their useful life. Many of the locations have three switches at the entrance door to control the lighting in the space. In all of the newer classroom spaces, a second switch is located by the white board and is accessible from the entrance door. This is now an energy code requirement and any renovations will require a second lighting switch to enable the illumination in the space to be reduced by one half.

There is a new classroom wing and a wing where major renovations took place, to create a new science wing. These areas have aircraft cable suspended direct/indirect classroom lighting, with adjacent vaulted exposed corridor using similar lighting. Other newly renovated areas have traditional 2x4 prismatic lens fixtures, recessed in the new ceilings.

As noted in the Middle School report, a comprehensive existing fixture fluorescent ballast and lamp retrofit was performed for the Middle and High Schools. This work was performed to save energy and the cost was likely recouped in part by a power company rebate program. The work is ultimately saving energy, by reducing the energy consumed by each light fixture. In almost all cases, the percentage of the energy save, results in reduced light output from the light fixture. This does not appear to be a negative, as the levels of light do not adversely affect the tasks involved. This is a great tradeoff, which allowed the district to simply reuse the existing light fixtures, retrofitted in place.

With the exception of the Gym, Wrestling Room, Media Center, New Classroom Wing, Science Wing and a most recently remodeled Metal Shop (Science Labs) area, we would recommend a complete replacement of the lighting fixtures as part of any major renovations to the building. The lighting technology available today, in consort with the available rebates, makes it a win/win situation for remodeling. Lighting fixtures utilizing HPT8 and T5 lamps, with electronic ballast, are being produced with greater efficiencies and performance. There are many options available to the designer, including recessed and aircraft suspended products. In a Middle School or High School setting, we would recommend a recessed ceiling mounted solution. Lighting controls which include occupancy sensors, stepped dimming, and daylight harvesting, should be considered in all areas that compliment those methods. We note that in many of the existing storage or similar occupancy locations, the school is already using spring wound timers or electronic occupancy sensors. We would also recommend a comprehensive, automated means to control the overall lighting systems to further control energy consumption throughout the building. This can be accomplished with Lighting Control System which would also be used for the exterior lighting as well.

Exterior Lighting Systems:

The exterior lighting systems consists of building mounted products, coupled with utility pole mounted fixtures. Most building mounted product is damaged or damaged beyond repair. Many of the wall mounted light fixtures have damage consistent with Ultraviolet exposure, (discoloring of the plastic lens media). These should be replaced. The pole mounted product is assumed to be leased from the power company. We would recommend replacing the area lighting with new anchor based pole mounted area lighting for the parking areas, driveways and sidewalks. This would be wired to, and controlled by, the High School building electrical systems.

Emergency Lighting & Exits systems:

Here is an area where recent upgrades took place as part of Life Safety Upgrades. With very few exceptions, we find the emergency lighting and Exit Sign systems in excellent shape and code compliant. A full review of the placement would need to take place again as part of any major renovations, to augment and reuse product where feasible.

Fire Alarm System:

The Fire Alarm Control Panel is fairly new and of updated addressable technology. The system appears to be a voice/evacuation system with speaker/strobes and strobe only devices. The system is complimented with corridor ceiling mounted smoke detectors as required. Coverage of notification and detection appears compliant and adequate.

School Intercom and Paging Systems:

The school intercom system also functions as a class change system, by sending a tone over the speakers. Classrooms and most occupied spaces have wall mounted call switches. The intercom system switch-bank style console is located in the main office, and has 125 intercom links or switches. The system is as manufactured by Bogen systems, serviced by Williams Communications. We would recommend that the system be replaced with an integrated multi-communication system that allows for keyed handsets in each classroom, with the ability to communicate room to room, and to allow certain types of outside phone calls thru the phone system as required. In most cases, existing wiring and speakers could by reused. Call switches would be replaced with telephone handsets or desk-sets. A new electronics equipment package and administrative desk-set would replace the existing switch console complete. A Bogen Multicom would be an example of a product suitable for this building.

Telecommunications: Voice and Data:

It appears the structured wiring systems in the building are of recent vintage for both voice and data systems. Jack density appears reasonable, to be confirmed by program requirements.

Security and Surveillance:

We observed keypad locations, passive infrared sensors and door contact hardware. This pretty much sums up the security/intrusion system. It appears that the system is operational and of recent vintage. We see no improvements here, short of program required additions, as deemed appropriate in any renovation project. In addition it is our understanding that the school has 30 or more cameras with Digital Video Recorders for surveillance of the campus.

Clock System:

The school presently has a central clock system that is operational in most areas. It appears that as clocks are failing, they are being replaced with battery quartz clocks to save money. System clocks are traditionally expensive to replace or have repaired. We would recommend replacing system clocks with battery powered quartz clocks as existing system clocks fail.

Closing Summary & Comments:

The High School has undergone some well needed electrical upgrades including panelboards, fire alarm and service entrance replacement. Recent additions and renovations have provided some upgrades to the media center and science wings. The additions and renovations have electrical equipment and wiring that provide wiring consistent with technology available today. With that said, we do not recommend any significant electrical work in those areas. The biggest electrical issues with the High School Building are focused on replacement of the older interior and exterior lighting, a new integrated school intercom system and the addition of general duplex receptacles and circuits to each classroom or similar space.

Engineers Opinion of probable costs: The following opinions of costs are based on current construction costs and our experience with similar project types.

Main Electrical Service Upgrade:
Engineers Opinion of probable cost: $100,000 Dollars

Interior Lighting and Controls:
Engineers Opinion of probable cost: $690,000 Dollars

Exterior Lighting and Controls:
Engineers Opinion of probable cost: $ 50,000 Dollars

Integrated School Intercom System:
Engineers Opinion of probable cost: $460,000 Dollars

Total Electrical Improvement for the Timberlane Regional High School:

Engineers Opinion of probable cost: **$1,300,000 Dollars**

Sincerely,

Lenny Edmunds

YEATON ASSOCIATES, INC.
MECHANICAL ENGINEERING

66 Jackson Street • Littleton, New Hampshire 03561 • 603-444-6578 • FAX 603-444-2364

October 21, 2008
YA08067C

Lavallee/Brensinger, P.A.
155 Dow Street - Suite 400
Manchester, NH 03101

Attn: Lance Whitehead, Project Manager

Re: Timberlane HS/MS Facility Assessment
Plaistow, New Hampshire

Dear Lance,

We offer the following mechanical systems assessment and related systems recommendations based on a review of the available mechanical construction documents, a meeting with the school administrators, and a building walk-through held on September 19, 2008 to observe and assess the current condition of the existing Timberlane High School and Middle School facilities.

The existing High School was built in 1966 and has undergone three additions – 1980, 1987 and 2000 – totaling 167,840 SF. The existing Middle School was built in 1975 and has undergone three additions – 1984, 1996 and 2000 – totaling 127, 617 SF.

<u>High School Mechanical Systems</u>

Boiler Plant

The boiler plant consists of two generations of installations. The first set of boilers was installed as part of the 1997 project and the second set of boilers was installed in 2003. The units are natural gas fired condensing Aerco boilers with efficiency ratings in the 90%+ range. The boilers are individually vented out the side wall of the mechanical room and have sealed combustion intakes. The boilers are served by a 2" gas main. The utility entrance and meter is located just outside the boiler room. The boiler plant is in good working condition, has an expected lifespan of 20-25 years and should support the building for the next 15-20 years. The boiler plant provides heat for the Performing Arts Center. In the event program dictates a building expansion, the existing boiler plant does not have spare capacity and will require expansion.

The boilers are piped into a supply and return manifold which supplies the High School as well as the Performing Arts. Hot water is circulated from the boiler room around the facility via two base mounted centrifugal pumps. The pumps operate in a primary/standby capacity and have recently been retrofitted with variable speed drives. The pumps are in good working order. In the event program dictates a building expansion, the existing domestic hot water plant does not have spare capacity and will require expansion.

Domestic hot water is generated with three Triangle Tube Phase III 119 gallon indirect fired (via the boiler) tanks piped to a dedicated Aerco boiler. These tanks were installed as part of the 1997 project and are in good working order. The expected lifespan of these tanks is 15-20 years. A code compliant tempering valve and DHW recirculation pump is installed.

Kitchen
The kitchen cook line has a stainless steel exhaust hood and a roof mounted exhaust fan. The hood and fan are adequately sized for the application. The hood is equipped with code compliant fire suppression. They appear to be original and approaching the end of their expected useful life. The make-up air system has been abandoned in place in no longer operates. The dishwasher is vented through the roof to an exhaust fan. The grease trap appears to be original and approaching the end if it's expected useful life. The kitchen cookline is served with a dedicated LP Gas system, separate of the building natural gas service. Complete systems replacement is recommended.

Fire Protection
The facility has an NFPA compliant sprinkler system including a remote diesel fire pump. The pump is located in a fire pump house located away from the buildings adjacent to the ball fields. The fire pump is 125 HP and discharges 750 gallons per minute. The pump sits on top of 30,000 gallon underground cistern. Any renovation will require the rework of piping and sprinkler heads. In the event program dictates a building expansion, the fire pump and cistern capacity will have to be examined.

Gym
The gym is currently served by four heating and ventilating units located within the gym suspended from the roof structure. The units distribute air from exposed ductwork high in the gym and are returned through low ducted return grilles. It appears the units were retrofitted with CO2 ventilation controls within the last 5-10 years, but the controls were not functioning at the time of our visit. The ventilation rates do not meet current codes. The acoustics in the gym are poorly affected by the operation of the units. The units appear to be original and approaching the end if their expected useful life. Complete systems replacement is recommended.

Locker Room
The exhaust quantities in the locker room were noticeable deficient. The exhaust grilles, ductwork and rooftop exhaust fans are undersized to achieve current standards. The grilles and ductwork appear to be original to the building. The fans may have been replaced during on an on going maintenance plan. The plumbing fixtures are antiquated; do not meet ADA requirements or energy code flow requirements. In general, the mechanical systems are approaching the end of their useful life. Complete systems replacement is recommended.

Weight Room and Wrestling Room
These spaces are currently served by a recently installed packaged rooftop unit to provide heating, ventilating and air conditioning. The unit is in good condition and has an expected life span of 15-20 years. There are reports of the unit being noisy; duct modifications and

sound silencers may be required to attenuate the noise. It was also observed that a vapor issue is causing paint to peel on the exterior wall. The expected lifespan of these units should support the building for the next 15-20 years.

Typical Classrooms

Classrooms are currently heated, ventilated and partially air conditioned with packaged roof mounted Des Champs energy recovery units. The units consist of a supply fan, exhaust fan, energy recovery wheel, hot water coils and a packaged DX cooling coil. The units were installed as part of the 2000 project and appear in good working condition. Several of the units have roof mounted ductwork that is insulated and covered with all weather aluma-guard jacket similar to FlexClad 400. The jacket has begun to deteriorate in the weather and should be replaced with in the next 3-5 years.

Perimeter radiation provides heat. The radiation appears to be original to the building. The enclosures are damaged throughout and fins had collected years of dust buildup.

As part of a mechanical system upgrade, the classrooms have displacement ventilation diffusers located at the floor level providing hearting and ventilation to the space. In most cased the ductwork is run exposed within the classroom, but appears to be withstanding to general wear and tear. The duct sizing and ventilation rates appear to meet current code. We experienced multiple rooms where the diffusers were blocked or partially blocked poorly affecting the performance of the system. General duct rework at a minimum will be required to accommodate the new or current classroom layouts.

Wood Shop

The wood shop is currently heated and ventilated by a rooftop energy recovery unit. The shop has displacement ventilation diffusers located at the floor level. The ductwork is run exposed in the shop and in most cases has held up to the general wear and tear of the shop environment. Supplemental heat is provided by a hydronic unit heater and baseboard radiation. An indoor duct collector is ducted to several dust generating machinery. The dust collector installation does not meet current codes and should be replaced.

Science Classrooms

Rooms with fume hoods are vented directly to the roof with dedicated exhaust fans. No sash height alarms were present. Emergency showers and eyewash stations were present, but not always accessible due to storage. The lab sinks and gas cocks appear to be original to the building. No acid waste neutralization appears to be installed. In general, a modernization of the labs is recommended.

Plumbing Fixtures

The age and condition of the plumbing fixtures vary throughout the facility, however even the best fixtures are only in fair condition. Most of plumbing fixtures do not comply with ADA requirements, do not comply with current energy code flow requirements or are worn enough to warrant replacement. Complete replacement is recommended.

Automatic Temperature Controls

Most of the building is served by a DDC Invensys controls system. The system is considered current technology and will continue to serve the building well for another 15-20 years. There is one are in the building that still remains pneumatic controls and should be replaced with DDC. In the event program dictates a building expansion, the DDC system can be expanded to handle the building addition.

<u>Middle School Mechanical Systems</u>

Boiler Plant

The boiler plant consists of four natural gas fired Weil McLain cast iron sectional gas fired boilers and vented through a masonry chimney. Each boiler has a dedicated injection pump. When new, the boiler has a combustion efficiency of 80%. The current efficiency is estimated at 70-75%. Hot water is circulated through the building by two base mounted centrifugal pumps. The boiler plant appears to be approximately 20 years old and will be approaching the end of their expected useful life within the next five to seven years years.

Domestic hot water is generated by an AO Smith 100 gallon indirect tank piped from the main boiler plant loop with a dedicated pump reacting to demand. The tank has an output of 362 gal/hr. The indirect tank is the primary tank and operated when the boiler plant is active during the heating months. For the shoulder seasons and summer months, domestic hot water is generated with a Bradford White 80 gallon electric hot water heater. The tank has an output of 363 gal/hr. Both are in fair condition, but will be approaching the end of their expected useful life within the next 5-7 years.

There are several electric hot water heaters adjacent to janitor's sinks throughout the building. They appear to be original and most are beyond their useful lifespan.

Complete replacement of the entire boiler plant is recommended.

Domestic Water

The building is served by a drilled well. The water entrance is located in the boiler room. The well pressurization system appears to have been recently replaced. The system is in good working condition, has an expected lifespan of 15-20 years and should support the building into the future.

Fire Protection

The facility has an NFPA compliant sprinkler system including a electric fire pump. The pump is located within the building. The fire pump is 20 HP and discharges 250 gallons per minute. The pump sits in top of a 30,000 gallon underground cistern. In the event program dictates a building expansion, the fire pump and cistern capacity will have to be examined.

Cafeteria

The cafeteria is served by a dedicated rooftop unit. The ductwork and diffuser layout does not facilitate proper flow to the occupant area, the ventilation rates do not met current code for the current occupant load. The unit is failing and has reached the end of it's useful life. Complete replacement is recommended.

Typical Classrooms

Most classrooms are currently heated, ventilated and air conditioned with packaged rooftop units. These units are relatively new and replaced original make-up air units. Most classrooms have one supply diffuser and appear to be under ventilated and cooled for the current classroom configuration. To take the building into the future, these units could remain, however an energy recovery wheel should be added to boost the outside air and cooling capabilities. Classroom ductwork should be reworked to provide better air distribution.

There is one classroom wing that has ventilation only and no cooling. This is a displacement ventilation system and was installed as part of the 1997 project. The system is in good working order and has an expected useful lifespan of 15-20 years.

Automatic Temperature Controls

The controls system is a mixture of DDC and pneumatic. The controls compressor is located in the boiler room and has received regular service. The pneumatic is still functioning well, but replacement is recommended to bring the entire building under DDC control.

Plumbing Fixtures

The age and condition of the plumbing fixtures vary throughout the facility, however even the best fixtures are only in fair condition. Most of plumbing fixtures do not comply with ADA requirements, do not comply with current energy code flow requirements or are worn enough to warrant replacement. Complete replacement is recommended.

Cost Estimate

The following costs are probable costs for an upgrade and renovation of the buildings. These costs do not consider building additions or significant program changes.

High School Mechanical = $3,400,000
High School Plumbing= $680,000
High School Controls=$340,000

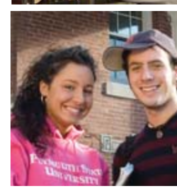
Middle School Mechanical=$2,600,000
Middle School Plumbing=$520,000
Middle School Controls=$260,000

Please do not hesitate to call if you have any questions regarding this report.

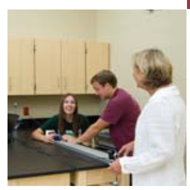
Respectfully,

Matthew Wilson
Project Manager

Middle School Building Program



TIMBERLANE REGIONAL SCHOOL DISTRICT (SAU 55)



Timberlane Middle School and
High School Existing Facilities
Assessment and Conceptual Planning

October 24, 2008

Lavallee Brensinger ARCHITECTS

Your mission inspires us. Our creativity and knowledge empower you. **Together we achieve excellence.**

Lavallee Brensinger Architects 155 Dow Street, Suite 400 Manchester NH 03101 tel 603-622-5450 fax 603-622-7908 web LBPA.com

Lavallee Brensinger ARCHITECTS

Timberlane Regional Middle School Building Program

- Middle School Building / Space Program

  Givens:

  -Enrollment: 1100 Student (NESDEC Projections and current enrollments)

  -Grades 6, 7, 8 (Current Configuration)

  -Current NH Department OF Education Standards (Ed 321)

- Middle School Education Specifications

  -Attached Draft dated October 2008

- TRMS Current Curriculum

  -Available online or through SAU Office

Timberlane Regional Middle School Building Program

October 24, 2008

Room Type	Persons/ Area	Min NSF/ Person	Min NSF/ Area	Adjusted	Number Req'd	Total Area	Comments
EDUCATIONAL SPACE							
6th Grade							
							4 "pods" per grade
Classrooms	24	32	768	850	16	13,600	1 Science CR per pod
Small Group Classroom / Coordination	12	32	384	425	4	1,700	1 Operable wall / paired CR per pod
SGC / Special Education	12	32	384	425	4	1,700	
Storage				100	4	400	
Copy Center / Work room				100	4	400	
						17,800	
7th Grade							
							4 "pods" per grade
Classrooms	25	32	800	850	16	13,600	1 Science CR per pod
Small Group Classroom / Coordination	12	32	384	425	4	1,700	1 Operable wall / paired CR per pod
SGC / Special Education	12	32	384	425	4	1,700	
Storage				100	4	400	
Copy Center / Work room				100	4	400	
						17,800	
8th Grade							
							4 "pods" per grade
Classrooms	25	32	800	850	16	13,600	1 Science CR per pod
Small Group Classroom / Coordination	12	32	384	425	4	1,700	1 Operable wall / paired CR per pod
SGC / Special Education	12	32	384	425	4	1,700	
Storage				100	4	400	
Copy Center / Work room				100	4	400	
						17,800	
Art							
Art Studio Classroom	25	60	1,500	1,400	2	2,800	Include Display Areas
Graphics / CADD Lab	25	30	750	850	2	0	Use Basic CPU Labs for Graphics
Art Classroom w/ Pottery Lab	25	60	1,500	1,400	2	2,800	Art Classroom w/ Clay traps / Conc Floor
Office/ Work / Coordination Area	2			200	2	400	
Kiln	1			80	2	160	
Storage				200	2	400	
						6,560	

Timberlane Regional Middle School Building Program

October 24, 2008

Room Type	Persons/ Area	Min NSF/ Person	Min NSF/ Area	Adjusted	Number Req'd	Total Area	Comments
Family and Consumer Sciences							
Culinary Lab / CR	25	75	1,875	1,400	1	1,400	
Sewing Lab / CR	25	75	1,875	1,400	1	1,400	
Business / Career Lab	25	30	750	850	1	850	Flexible CPU Stations w/ project layout space. Distance learning capable
Office	3	75	225	225	1	225	
Frig / Freezer / Dry Culinary Storage				250	1	250	
Sewing Storage				100	1	100	
Business Storage				100	1	100	
						4,325	
World Languages							
Language Labs	24	30	720	850	6	5,100	2 Classrooms per Grade, AV capable. Distance learning capable. Operable wall / paired CR
Office/ Work / Coordination Area	2			225	2	450	
						5,550	
Science							
Biology /Chemistry Lab	24	60	1,440	1,440	2	2,880	
Science CR /Physics Lab	24	60	1,440	1,440	2	2,880	
Green House			100	100	1	0	Integrate into Biology
Storage / Prep Rooms / Work Area			250	250	3	750	Shared and Placed Between Labs
Office/ Work / Coordination Area	3	75	225	250	1	250	Integrate into prep rooms
						6,760	
Technology Education							
Computer Labs	24	30	720	850	4	3,400	
Integrated Classroom Labs	12	36	432	425	2	0	Mobile Wireless Labs Shared by Other Departments
Office/ Work / Coordination Area	3	75	225	225	1	225	
						3,625	
Industrial and Engineering Technology							
Engineering Lab	24	30	720	850	1	850	Flexible CPU stations w/ project layout space
Wood Working / Metal Lab	16	75	1,200	1,200	1	1,200	
Graphics / CADD Lab	24	30	720	850	1	0	Use Basic CPU Labs for CADD
Metal Storage				100	1	100	
Wood Storage				200	1	200	
Office/ Work / Coordination Area	2	75	150	150	1	150	
						2,500	

Lavallee Brensinger Architects 155 Dow Street, Suite 400 Manchester NH 03101 tel 603-622-5450 fax 603-622-7908 web LBPA.com

Room Type	Persons/ Area	Min NSF/ Person	Min NSF/ Area	Adjusted	Number Req'd	Total Area	Comments
Special Education							
Special Education Flex Area				850	2	1,700	1 suite per house w/ operable / flexible walls
Meeting Area / Small Group CR	12	30	360	425	2	0	Shared by Other Departments
Life Skills Apartment				850	1	850	Culinary area, Restroom, Teaching Area
Physical Therapy Room				425	1	425	
Occupational Therapy Room				425	1	425	
ASD Room				850	1	850	
Swing Room				150	1	150	
Quiet Room				50	1	50	
						4,450	
Music / Perf. Arts							
Instrumental Band Room	50	25	1,250	1,400	2	2,800	
Chorus	50	15	750	1,000	1	1,000	
Performance Area / Black Box	200	15	3,000	3,000	1	3,000	
Small Practice Room	1			40	4	160	
Large Practice Room	2			80	4	320	2 for chorus, 2 for Band
Offices	3	75	225	225	1	225	
Storage Areas				400	2	800	
Instrument Storage				800	1	800	
						9,105	

Total Education Spaces 96,275 Net Square Feet

CORE SPACE

Administration

Room Type	Persons/ Area	Min NSF/ Person	Min NSF/ Area	Adjusted	Number Req'd	Total Area	Comments
Principal	1			250	1	250	
Assistant Principal	1			200	3	600	1 in each "House" & 1 in Core
Curriculum Coordinator	1			150	2	300	
Admin Support / Open Office	4	75	300	300	1	300	
SRO	1			150	1	150	
PAS Office/Room				450	1	450	Suspension Room
Reception/Waiting	6			150	1	150	
Work Room				400	1	400	Integrated into open office
Large Conference / Meeting	12			650	1	650	Shared w/ Guidance
Small Conference / Meeting	6			350	1	350	
File / Record Storage				300	1	300	
Mail Area	1			150	1	150	
						4,050	

Health Office

Room Type	Persons/ Area	Min NSF/ Person	Min NSF/ Area	Adjusted	Number Req'd	Total Area	Comments
Nurse Office	1			150	1	150	
Entry / Waiting				200	1	200	
Work Area	1			200	1	200	
Sick / Treatment Area	1			150	1	150	
Shared Treatment Area	2	75	150	150	2	300	
						1,000	

Guidance

Room Type	Persons/ Area	Min NSF/ Person	Min NSF/ Area	Adjusted	Number Req'd	Total Area	Comments
Head Guidance Counselor	1			200	1	200	In Main Administration Area
Counselors	1			150	4	600	1-2 in each "House" and 1-2 in Core
Student Assistance	1			150	1	150	
Guidance Waiting	4			100	1	100	
Display Area				100	1	100	
Large Conference	12			650	1	0	Shared with Main Admin
Small Conference / Meeting	6			250	1	250	Shared by Other Departments
Small Group Instructional	12	36	432	450	1	450	
File / Record Storage				200	1	200	
						2,050	

Timberlane Regional Middle School Building Program

October 24, 2008

Room Type	Persons/ Area	Min NSF/ Person	Min NSF/ Area	Adjusted	Number Req'd	Total Area	Comments
Special Education Offices							
Special Education Director	1			200	1	200	In Main Administration Area
Open Office / Work Room	4	75	300	300	1	0	Shared with Main Admin
Testing Room				100	1	100	
File / Record Storage				150	1	150	
Small Conference / Meeting	6	40	240	240	1	240	
						690	
Media Center							
Library / Stacks	50	50	2,500	3,000	1	3,000	
Reading Area	15	50	750	1,000	1	1,000	Integrated into main area
Computer Stations	50	15	750	1,000	1	1,000	Integrated into main area
Circulation	2			200	1	200	
Librarian Office				150	1	150	
CPU Lab	16	50	800	900	1	900	Shared CPU Labs w/ Access to outside
Small Group Instructional	12	36	432	450	1	450	Shared by Other Departments
Librarian Work Room				200	1	200	
Library Storage				250	1	250	
						7,150	
Health & Physical Education							
Main Gym	75	150	11,250	14,000	1	14,000	Dividable into 2 Courts or 3 teaching areas
Fitness Room	25	50	1,250	1,400	1	1,400	
PE Classroom	25	36	900	900	1	900	
Girls Locker Suite	25	25	625	800	1	800	Includes Lockers, Showers, Restrooms
Boys Locker Suite	25	25	625	800	1	800	Includes Lockers, Showers, Restrooms
Faculty Coordination Room				200	1	200	
Coaches				100	2	200	
AD / PE Office				200	1	200	
Referee Locker Room				100	1	100	
Laundry Room				200	1	200	
Team Rooms				250	2	500	Adjacent / Within the Locker Suites
Training Room				250	2	500	
Storage				1,000	1	1,000	
						20,800	

Lavallee Brensinger Architects 155 Dow Street, Suite 400 Manchester NH 03101 tel 603-622-5450 fax 603-622-7908 web LBPA.com

Timberlane Regional Middle School Building Program

October 24, 2008

Cafeteria

Room Type		Persons/ Area	Min NSF/ Person	Min NSF/ Area	Adjusted	Number Req'd	Total Area	Comments
Dining Area		225	18	4,050	4,000	1	4,000	Based on 225 Students per sitting
Serving Area					800	1	800	This allows for 5 lunch periods per the Ed Spec
Kitchen					1,200	1	1,200	5000sf dining would allow for 4 Lunch Periods
Dry Storage					250	1	250	6500sf dining would allow for 3 Lunch Periods
Walk-In Freezer					150	1	150	
Walk-In Refrigerator					150	1	150	
Locker Area					100	1	100	
Toilet					80	1	80	
Loading Area					200	1	200	
Cafeteria Office		1			100	1	100	
							7,030	

Maintenance

Room Type		Persons/ Area	Min NSF/ Person	Min NSF/ Area	Adjusted	Number Req'd	Total Area	Comments
Maintenance Bay					480	1	480	
Custodial Closets					30	10	300	Distributed Throughout the School
Office					150	1	150	
Work / Repair Area					300	1	300	
Storage Bay					480	1	480	
Building Storage					1,000	1	1,000	Shared By Entire Building
							2,710	

Tech Support

Room Type		Persons/ Area	Min NSF/ Person	Min NSF/ Area	Adjusted	Number Req'd	Total Area	Comments
Central Server Room					400	1	400	
Satellite Server Room					80	2	160	
IT Office					150	1	150	
IT Repair / Workroom					150	1	150	
							860	

Total Core Spaces 46,340 Net Square Feet

Room Type		Persons/ Area	Min NSF/ Person	Min NSF/ Area	Adjusted	Number Req'd	Total Area	Comments

EXTERIOR SPACES

Fields / Events (shared with High School)

Room Type		Persons/ Area	Min NSF/ Person	Min NSF/ Area	Adjusted	Number Req'd	Total Area	Comments
Track and Field Events						1		Includes Long Jump, Triple Jump, Discus, Pole Vault
Running Track						1		
Baseball Field						3		
Softball Field						4		
Football Field						2.5		
Soccer /Lacrosse Field						3		
Field Hockey						2		
Tennis Courts						4		
Bleachers - mobile						4 sets		
Field Athletic Storage						1	1,200	
Field Maintenance Storage						1	1,200	
Field Restrooms						1	1,200	
Concessions						1	600	

Site Features

Room Type		Persons/ Area	Min NSF/ Person	Min NSF/ Area	Adjusted	Number Req'd	Total Area	Comments
Bus Parking		12	600	7,200		1	0.17	Acres
Faculty Parking		120	300	36,000		1	0.83	Acres
Bus Drop Off							2.00	Acres
Parent Drop Off							1.00	Acres
Loading Dock Ramp		2	1,200	2,400		1	0.06	Acres
Maintenance Parking		5	300	1,500		1	0.03	Acres
Visitor Parking		12	300	3,600		1	0.08	Acres
							4.08	Acres

137 Total parking

Program Summary

Building Program

Total Core Spaces	46,340	Net Square Feet
Total Education Spaces	96,275	Net Square Feet
Total Building Spaces	142,615	Net Square Feet Built for capacity of 1100
Total Gross Area	**203,736**	Gross Square Feet (@70% Efficient)

Total Teaching Spaces **93**

185 GSF/student (at 1100 kids)
140 DOE Max Per Student
187 DOE Max Per Student at 75% Utilization

Space Summary

Classrooms*	**48**	**FACS Labs/Areas**	**3**
Small Group Classrooms	**17**	**Tech Ed Labs**	**2**
Science Labs	**4**	**Computer Labs**	**5**
Art Studios	**4**	**Music Teaching Spaces**	**4**
Physical Ed Areas	**5**		

The following spaces are part of the net to gross number	
Electrical	**Main Entry**
Mechanical Room	**Other Entrances**
Toilet Rooms	**Main Circulation Areas**

Lavallee Brensinger ARCHITECTS

- Middle School Education Specifications

Timberlane Regional Middle School

Response to the Educational Specifications

Request of the Architects

Michael Hogan, Principal

October, 2008

Timberlane Middle School is comprised of grade 6, 7, and 8, with a student population of just over 1,100 students. There are twelve (12) academic teams, four (4) from each grade. Middle school philosophy suggests that teaming is at the heart of learning for young adolescents. Creating a school building that allows teachers to work together to create meaningful learning experiences for children is essential to all curriculum delivery. Integrating subject matter is essential to meaningful learning and can be enhanced substantially through building design.

Middle schools use teaming to address learning by creating schools within schools. Although curriculum is standardized across all grade levels within the school, teams have the autonomy to work with no more than one hundred students, essentially making a large school seem small. Building design should support the team structure through a pod design that has all classrooms located adjacent to each other. Within the pod, classrooms should include rooms for language arts, mathematics, social studies and science. The pod classrooms should also include flexible walls that can turn one classroom into two in order to work on specific curriculum assignments or to hold team meetings. Classrooms should be equipped with the latest wireless technology so that it can be accessed within the team structure. Each pod should include a half-sized classroom for team teachers to meet, and another half-sized room for the implementation of special education services. Central to the pod would be a corridor leading to the classroom areas that would include all student lockers, bathrooms, and water fountain. This locker area would allow for safe flow of students entering and exiting each classroom.

TRMS current structure of twelve teams would require a building that has 12 pods. Currently, we locate all students in wings designed specifically for each of the three grades. However, careful consideration should be given to a design that would create two schools within building comprised of two teams from each grade. This separation would allow students to remain in one smaller school, or House, with no more than 600 students for the three years of middle school. Professional learning communities would develop across grade levels, and thus lesson the degree of transition. In essence, students would enter and exit into a school within a school model, be a part of a team structure within a pod, and transition smoothly into high school.

Middle school education includes much more than the core requirements of the major subject areas. The foundation for interest in exploratory subjects such as art, family and consumer science (FACS) and technology are essential in developing student interest and appreciation. In order for these subjects to be part of all students' education, classrooms designated for the implementation of their curriculum have to be created. Each of these exploratory subjects has their own requirements based on state standards. Currently the state requires 100 hours of instruction in each area over three years.

All students should have exploratory art classes in rooms that are only used for that subject. Design should include large flexible spaces with excellent lighting and significant storage space. Space should be designated for display of student work. To maximize space and promote a professional learning community model, art rooms should be adjacent to each other, and have an office designated for planning purposes.

FACS classes currently include cooking, sewing and business and career education. All three areas represent opportunities for students to begin to develop interest and expertise that can become a lifelong skill. Each classroom should be treated as a laboratory and equipped as such. A cooking lab specifically designed with the latest equipment, in a space large enough to accommodate up to 25 students is most appropriate. Flexible space with a lot of storage is paramount to sewing instruction. The room should be designed for, and used only for sewing related instruction. The business and career lab would include technology that would allow for distance learning and the development of community business partnerships.

World language is fast becoming another essential part of the middle school experience. Living in a global economy dependent on language acquisition makes this essential. Students should have the opportunity to work in a lab setting, complete with audiovisual equipment and distance learning apparatus. Students would have the capability of taking world language for the entire year at all three grade levels. Two classrooms per grade level should be designated as solely world language rooms. Flexible walls that allow classes to combine for learning activities would be suggested. A common area for planning purposes would complete the area.

Teaching students about wellness includes a three-pronged approach. All middle level students would have a p.e/wellness block every day of the week. The gymnasium would be created to house three stations of physical activity, enough for an entire team, while adjacent fitness rooms and classrooms would allow for health instruction. These rooms would be created as flexible spaces for activities such as yoga, dance or weight training for example. This comprehensive approach would extend outside with several outdoor education opportunities, such as ropes courses and climbing walls. The wellness curriculum would use the gym space, classroom space, and the outdoor centers to craft individual learning opportunities for students. A designated faculty planning room would serve all wellness teachers. Designated male and female locker rooms with separate adult facilities would be essential. A team meeting area for both male and female athletic teams gives coaches a space to meet with players. This space, along with the library, would have separate entrances in order to remain open for extended hours for public events. A wide range of flexible use athletic fields and recess accessible areas would be created next to the wellness center. Indoor and outdoor storage space is required.

The middle school music program would include opportunities for all students to explore interest in sing, playing an instrument, or participating in the performing arts. Separate rooms designated for each strand would be essential, requiring two rooms for instrumentals, a chorus room, and a small performance room. The performance room would have a stage and hold up to 200 people in the audience. This would allow for ongoing productions that are done on a smaller scale than those requiring a larger theater. Separate office space for the music teachers and plenty of storage would be important.

The middle school model of instruction is based on inclusion of all students in classrooms with teams. However, designated areas for special education services would be needed in both houses of the middle school. The designated areas should include flexible spaces with portable walls that can be moved to accommodate the changing student population. One large area in each house that would allow TRMS to place students in either House and get the services they require would be the best for all children. The special ed. Suite would need bathroom facilities equipped for handicapped children and adults. One important function of special education is the access to meeting rooms that would allow for I.E.P. meetings, required by law, to take place between parents and staff. These meeting rooms should be situated with one in each House. Additional rooms should be created for related services, suchas physical therapy or occupational therapy.

The library space should be designed so that it can be accessed long after the school day is over. A separate entrance would allow students and groups to meet during the evening ion designated days. The library needs to be large enough to hold two classes at any given block during the day. It should be open enough to provide security and allow for large group presentations. It should be stocked with books, magazines, etc., but it should have all the latest technological capability. Although our new school will have information that can be accessed easily from all classrooms, it provides another layer of research for large groups, individuals, and after school students.

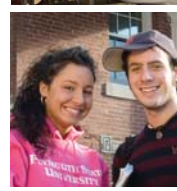
The cafeteria is another space that could provide after school opportunities for use. The middle school lunch program should be able to service up to 225 students every thirty minutes. Healthy choices presented to students and staff should be served quickly through a number of lunch lines. Students should be able to eat within 15 minutes and then gain access to a fresh air break (recess), for the remainder of time.

In a House system, guidance counselors and asst. principals work together in an office space within their House. They share a common area and have a designated secretary. They share a common meeting room where they can meet with parents, teachers or students jointly or separately.

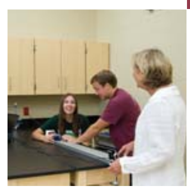
The main office would provide the primary entrance for all visitors to the school. The principal and other designated administrators, special ed. director and curriculum coordinator, have their offices in this space. Each administrator has a designated meeting room. Three secretaries provide initial security and administrative support.

Parking and bus loops should be separate. Designated visitor and staff parking should funnel adults through the main entrance. Bus traffic should funnel students through a designated secondary entrance/exit.

High School Building Program



TIMBERLANE REGIONAL SCHOOL DISTRICT (SAU 55)



Timberlane Middle School and
High School Existing Facilities
Assessment and Conceptual Planning

October 24, 2008

Lavallee Brensinger ARCHITECTS

Your mission inspires us. Our creativity and knowledge empower you. **Together we achieve excellence.**

Lavallee Brensinger Architects 155 Dow Street, Suite 400 Manchester NH 03101 tel 603-622-5450 fax 603-622-7908 web LBPA.com

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Timberlane Regional High School Building Program

- High School Building / Space Program

  Givens:

  -Enrollment: 1500 Student (NESDEC Projections and current enrollments)

  -Grades 9, 10, 11, 12 (Current Configuration)

  -Current NH Department OF Education Standards (Ed 321)

- High School Curriculum Analysis

  -Attached Current Classes and Enrollments

- High School Education Specifications

  -Attached Draft dated October 2008

- TRHS Current Program of Studies

  -Available online or through SAU Office

Room Type		Persons/ Area	Min NSF/ Person	Min NSF/ Area	Adjusted	Number Req'd	Total Area	Comments
EDUCATIONAL SPACE								
Art								
Art Studio Classroom		24	60	1,440	1,400	2	2,800	
Graphics / CADD Lab		24	30	720	900	1	900	Could share with Engineering Technology Dept
Pottery Lab		24	60	1,440	1,400	1	1,400	Art Studio Classroom w/ Clay traps and Conc Floor
DarkRoom		3			500	1	500	Adjacent to Graphics Lab for Digital Integration
Office / Work		1 to 2			200	1	200	
Storage					300	1	300	
							6,100	
Technology / Computers								
CPU Labs		24	30	720	900	3	2,700	900 sf labs for flexibility
CPU Business Lab		24	30	720	900	1	900	Flexible CPU Stations w/ project layout space
Shared Office / Work Area		2			100	1	100	
Storage					100	1	100	
							3,800	
English / Humanities								
Classrooms		24	36	864	900	9	8,100	900 sf classrooms (50% w/ adjoining for group teaching)
Small Group Classroom		12	36	432	450	2	900	Shared with other departments
Shared Office / Work Area		3	75	225	250	1	250	
Storage					100	1	100	
							9,350	
Social Studies / Humanities								
Classrooms		24	36	864	900	13	11,700	900 sf classrooms (50% w/ adjoining for group teaching)
Small Group Classroom		12	36	432	450	1	0	Shared by Other Departments
Open Teaching / Meeting		22	30	660	450	1	450	
Storage					100	1	100	
							12,250	
World Languages								
Classrooms		24	36	864	900	9	8,100	900 sf classrooms
Small Group Classroom		12	36	432	450	1	0	Shared by Other Departments
Shared Office		3	75	225	250	1	250	
Storage					100	1	100	
							8,450	

Timberlane Regional High School Building Program

October 24, 2008

Room Type	Persons/ Area	Min NSF/ Person	Min NSF/ Area	Adjusted	Number Req'd	Total Area	Comments
Mathematics						\	
Classrooms	24	36	864	900	10	9,000	
Small Group Classroom	12	36	432	450	2	900	Shared with other departments
CPU Classroom	24	30	720		2	0	Wireless mobile labs
Shared Office / Work Area	10	75	750	750	1	750	
Storage				100	1	100	
						10,750	
Home Technology							
Culinary Lab	20	75	1,500	1,400	1	1,400	
Sewing / Mult-purpose CR	20	75	1,500	1,400	1	1,400	
Shared Office / Work Area	2	75	150	150	1	150	
Frig / Freezer / Dry Storage				250	1	250	
Child Development Center	20	60	1,200	1,200	1	1,200	
Graphics / CADD Lab	24	30	720	900	1	0	Share with Engineering Technology Dep
						4,400	
Science							
Biology/Science Lab	24	60	1,440	1,440	3	4,320	With Fume Hoods
Chemistry Lab	24	60	1,440	1,440	3	4,320	With Fume Hoods
Science/PhysicsLab	24	60	1,440	1,440	3	4,320	
Green House				120	1	0	Integrate Into Biology Outside wall
Storage / Prep Rooms				200	4	800	Shared and Placed Between Labs
Classrooms	24	36	864	900	1	900	Shared w/ Other Departments
Shared Office / Work Area	4	75	300	200	4	0	Integrate into prep rooms
						14,660	
Industrial Technology							
Robotics Lab	16	75	1,200	900	1	900	
Dirty Lab / CR	16	75	1,200	1,200	1	1,200	
Graphics / CADD Lab	24	30	720	900	1	0	Share with Engineering Technology Dept
Metal Storage				100	1	100	
Wood Storage				200	1	200	
Shared Office	2	75	150	150	1	150	
						2,550	

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Timberlane Regional High School Building Program

October 24, 2008

Room Type	Persons/ Area	Min NSF/ Person	Min NSF/ Area	Adjusted	Number Req'd	Total Area	Comments
Engineering Technology							
Graphics / CADD Lab	24	30	720	1,200	1	1,200	Shared - Flexible CPU Stations w/ project layout space
Shared Office	2	100	200		1	0	Share with Industrial Technology Dep
						1,200	
Special Education / Alternative							
Classrooms	24	36	864	900	1	900	Learning Center
Life Skills Apartment	10			900	1	900	Culinary area, Restroom, Teaching Area
Small Group CR / Meeting	12	36	432	450	10	4,500	Learning Center
						6,300	
Music / Perf. Arts							
Band Room	120	25	3,000	3,000	1	3,000	
Chorus						0	Already In PAC
MIDI Lab	16	50	800	800	1	0	Reno Band Room in PAC to MIDI lab
Classroom	24	36	864	900	1	0	Reno Band Room in PAC to Classroom
TV Studio	12			900	1	0	In Media Center
Auditorium						0	Already In PAC
Dance Studio / Black Box	100	25	2,500	2,500	1	2,500	
Small Practice Room						0	Already In PAC
Large Practice Room						0	Already In PAC
Offices						0	Already In PAC
Storage Areas						0	Already In PAC
Instument Storage						0	Already In PAC
Lobby Addition				1,200	1	1,200	Already In PAC
						5,500	**Add to PAC**
Flex Classrooms							
Classrooms	24	36	864	900	2	1,800	Shared by All Departments
Small Group Instuctional	12	36	432	450	1	450	Shared by All Departments
						2,250	

Total Education Spaces	87,560	Net Square Feet

Timberlane Regional High School Building Program

October 24, 2008

Room Type	Persons/ Area	Min NSF/ Person	Min NSF/ Area	Adjusted	Number Req'd	Total Area	Comments
CORE SPACE							
Administration							
Principal	1			250	1	250	
Assistant Principal	1			200	4	800	
Curriculum Director	1			150	1	150	
Admin Support / Open Office	5	75	375	400	1	400	
SRO	1			150	1	150	
PAS Office/Room				450	1	450	Suspension Room
Reception/Waiting	6			300	1	300	
Work Room				600	1	600	Integrated into open office
Large Conference	12			650	2	650	2 Large Conf Rooms Shared w/ Guidance and Admin
Small Conference	6			350	2	700	
File / Record Storage				500	1	500	
Mail Area	1			200	1	200	
						5,150	
Health Office							
Nurse Office	1			150	1	150	
Entry / Waiting				200	1	200	
Work Area	1			200	1	200	
Sick / Treatment Area	1			150	1	150	
Shared Treatment Area	2	75	150	150	2	300	
						1,000	
Guidance							
Head Guidance Counselor	1			200	1	200	
Counselors	1			120	5	600	
Social Worker	1			150	1	150	
Psychologist	1			200	1	200	
Guidance Reception/Waiting	4	50	200	200	1	200	
Display Area				100	1	100	
Large Conference	12			650	2	650	2 Large Conf Rooms Shared w/ Guidance and Admin
Small Conference	6			250	1	250	
Small Group Instuctional	12	36	432	450	1	450	Shared by Other Departments
File / Record Storage			200		1	0	
						2,800	

Timberlane Regional High School Building Program

October 24, 2008

Room Type		Persons/ Area	Min NSF/ Person	Min NSF/ Area	Adjusted	Number Req'd	Total Area	Comments
Special Education								
Open Office / Work Room		4	75	300	300	1	300	
Office		1			150	2	300	
Testing Room					100	2	200	
Therapy Room					100	2	200	
Calming Room					100	1	100	
File / Record Storage					200	1	200	
Small Conference		6	40	240	250	1	250	
							1,550	
Media Center								
Library / Stacks		50	50	2,500	3,000	1	3,000	
Reading Area		15	50	750	1,200	1	1,200	Integrated into stacks
Computer Stations		50	15	750	1,200	1	1,200	Integrated into stacks
Circulation		2			200	1	200	Integrated into stacks
Librarian Office					150	1	150	
CPU Lab		16	50	800	900	2	1,800	Shared CPU Labs
Small Group Instuctional		12	36	432	450	1	450	Shared by Other Departments
Small Conference		6	50	300	300	1	300	Shared by Other Departments
Librarian Work Room					200	1	200	
AV / TV Studio					600	1	600	
AV Storage					100	1	100	
Library Strorage					250	1	250	
							9,450	
Health & Physical Education								
Main Gym		60	150	9,000	14,000	1	14,000	Dividable into 2 full Courts
Multi-Purpose / Mini Gym		24	75	1,800	7,200	1	7,200	Dance/Aerobics/Wrestling/PE Sports / 1 court
Fitness Room		24	50	1,200	2,000	1	2,000	
PE Classroom		24	36	864	900	1	900	
Girls Locker Suite		60	25	1,500	1,500	1	1,500	Includes Lockers, Showers, Restrooms
Boys Locker Suite		60	25	1,500	1,500	1	1,500	Includes Lockers, Showers, Restrooms
Coaches					100	2	200	
AD / PE Office					200	1	200	
Referee Locker Room					100	2	200	
Laundry Room					200	1	200	
Team Rooms					300	4	1,200	Adjacent / Within the Locker Suites
Training Room					400	1	400	
Storage					1,000	2	2,000	
							31,500	

Room Type	Persons/ Area	Min NSF/ Person	Min NSF/ Area	Adjusted	Number Req'd	Total Area	Comments
Cafeteria							
Dining Areas	500	20	10,000	10,000	1	10,000	Based on 3 periods of lunch for 1500 students
Serving Areas				800	2	1,600	
Kitchen				1,600	1	1,600	
Dry Storage				300	1	300	
Walk-In Freezer				200	1	200	
Walk-In Refrigerator				200	1	200	
Locker Area				100	1	100	
Loading Area				300	1	300	
Cafeteria Office				100	1	100	
						14,400	
Maintenance							
Maintenance Bay				480	3	1,440	In Separate Building
Custodial Closets				30	10	300	Distributed Throughout the School
Office				200	1	200	
Work / Repair Area				300	1	300	
Storage Bays				480	2	960	
Building Storage				1,000	1	1,000	
						4,200	
Tech Support							
Central Server Room				400	1	400	
Satelite Server Room				100	1	100	
IT Office	4	100	400	400	1	400	
IT Repair / Workroom				150	1	150	
						1,050	

Total Core Spaces 71,100 Net Square Feet

EXTERIOR SPACES

Fields / Events

Room Type		Persons/ Area	Min NSF/ Person	Min NSF/ Area	Adjusted	Number Req'd	Total Area	Comments
Track and Field Events						1		Includes Long Jump, Triple Jump, Discus, Pole Vault
Running Track						1		
Baseball Field						3		
Softball Field						4		
Football Field						2.5		
Soccer /Lacrosse Field						3		
Field Hockey						2		
Tennis Courts						4		
Bleachers - mobile						4 sets		
Field Athletic Storage						1	1,200	
Field Maintenance Storage						1	1,200	
Field Restrooms						1	1,200	
Concessions						1	600	
						Building Area:	**4,200**	

B

Site Features

Room Type		Persons/ Area	Min NSF/ Person	Min NSF/ Area	Adjusted	Number Req'd	Total Area	Comments
Student Parking		500	300	150,000		1	3.44	Acres
Bus Parking		12	600	7,200		1	0.17	Acres
Faculty Parking		120	300	36,000		1	0.83	Acres
Bus Drop Off							2.00	Acres
Parent Drop Off							1.00	Acres
Loading Dock Ramp		3	1,200	3,600		1	0.08	Acres
Maintenance Parking		10	300	3,000		1	0.07	Acres
Tech Ed Parking / Loading		6	300	1,800		1	0.04	Acres
Visitor Parking		12	300	3,600		1	0.08	Acres
							7.63	Acres

648 Total parking

Program Summary

Building Program

Total Core Spaces	71,100	Net Square Feet
Total Education Spaces	87,560	Net Square Feet
Total Building Spaces	158,660	Net Square Feet — Built for capacity of 1500
Total Gross Area	**233,324**	Gross Square Feet (@ 68% Efficient)

Total Teaching Spaces **97**

156 GSF/student (at 1500 kids)
160 DOE Max Per Student
188 DOE Max Per Student at 85% Utilization

Space Summary

Classrooms*	**45**	**FACS Labs/Areas**	**2**
Small Group Classrooms	**15**	**Tech Ed Labs**	**2**
Science Labs	**9**	**Computer Labs**	**6**
Art Studios	**4**	**Music Teaching Spaces**	**7**
Physical Ed Areas	**5**		

The following spaces are part of the net to gross number

Electrical	**Main Entry**
Mechanical Room	**Other Entrances**
Toilet Rooms	**Main Circulation Areas**

Lavallee Brensinger ARCHITECTS

- High School Curriculum Analysis

Timberlane Regional High School Curriculum Analysis

October 24, 2008

	Sections	Students	Portion of year?	Avg. Section Size	Seats/ year	Rooms/ year	Rounded up if not shared	Projected Classroom Type	Projected Classroom Size
Art									
H001 Intro Art C	14	295	0.5	21.1	147.5	7.0		Art Studio	1400
H002 Inter Art 2-D	7	134	0.5	19.1	67.0	3.5		Art Studio	1400
H003 Inter Art 3-D	3	47	0.5	15.7	23.5	1.5		Art Studio	1400
H005 Drawing C	1	17	0.5	17.0	8.5	0.5		Art Studio	1400
H007 Painting C	1	14	0.5	14.0	7.0	0.5		Art Studio	1400
H008 Illust & Cart C	1	18	0.5	18.0	9.0	0.5		Art Studio	1400
H010 Pottery C	2	43	0.5	21.5	21.5	1.0		Pottery Lab	1400
H012 Photography	5	58	0.5	11.6	29.0	2.5		CPU Graphics Lab	1200
H016 Graphic Design A	2	36	0.5	18.0	18.0	1.0		CPU Graphics Lab	1200
H017 Photography II	2	16	0.5	8.0	8.0	1.0		CPU Graphics Lab	1200
		Total Spaces / Day @ 8 periods @ .85 Util				2.8	3.0		
Music									
H022 Strides	2	37	0.5	18.5	18.5	1.0		Band Room	2000
H051 Survey Music C	2	57	0.5	28.5	28.5	1.0		Band Room	2000
H052 Chorus	1	53	1	53.0	53.0	1.0		Chorus Room	1500
H055 Concert Choir	1	70	1	70.0	70.0	1.0		Auditorium	
H056 Select Ensemb A	1	19	0.5	19.0	9.5	0.5		Band Room	2000
H057 Band	1	126	1	126.0	126.0	1.0		Band Room	2000
H058 Orchestra	1	55	1	55.0	55.0	1.0		Band Room	2000
H059 Color Guard	1	1	0	1.0	0.0	0.0		Band Room	2000
H061 Jazz Band A and C	1	35	0.5	35.0	17.5	0.5		Band Room	2000
H063 Theory I A	1	11	0.5	11.0	5.5	0.5		Typical Classroom	900
H065 Theory II A	1	7	0.5	7.0	3.5	0.5		Typical Classroom	900
H067 Intro Guitar C	4	55	0.5	13.8	27.5	2.0		Band Room	2000
		Total Spaces / Day @ 8 periods @ .85 Util				1.5	2.0		
Technology / Computers									
H103 Desktop Pub	1	21	0.5	21.0	10.5	0.5		CPU Lab	900
H105 Accounting I C	1	21	0.5	21.0	10.5	0.5		CPU Business Lab	900
H106 Accounting II C	1	13	0.5	13.0	6.5	0.5		CPU Business Lab	900
H107 Computer Ap C	13	284	0.5	21.8	142.0	6.5		CPU Lab	900
H115 Bus Mnt & Entr'ship	2	43	0.5	21.5	21.5	1.0		CPU Business Lab	900
H125 Marketing C	1	22	0.5	22.0	11.0	0.5		CPU Business Lab	900
H136 Basic Prog. II A	1	8	0.5	8.0	4.0	0.5		CPU Lab	900
H141 Web Page Design	6	131	0.5	21.8	65.5	3.0		CPU Lab	900
H142 Practicing Teaching A	1	13	0.5	13.0	6.5	0.5		CPU Lab	900
H144 Exploring Teaching A	2	21	0.5	10.5	10.5	1.0		CPU Lab	900

Timberlane Regional High School Curriculum Analysis

October 24, 2008

	Sections	Students	Portion of year?	Avg. Section Size	Seats/ year	Rooms/ year	Rounded up if not shared	Projected Classroom Type	Projected Classroom Size
H153 Basic Prog I C	1	11	0.5	11.0	5.5	0.5		CPU Lab	900
H154 Basic II C	1	4	0.5	4.0	2.0	0.5		CPU Lab	900
H155 Basic Prog I A	2	28	0.5	14.0	14.0	1.0		CPU Lab	900
H156 C++ Prog. A	2	24	0.5	12.0	12.0	1.0		CPU Lab	900
H159 C++ Prog II A	1	8	0.5	8.0	4.0	0.5		CPU Lab	900
H166 Intro to Java A	1	13	0.5	13.0	6.5	0.5		CPU Lab	900
H167 AP Computer Science	1	6	1	6.0	6.0	1.0		CPU Lab	900
H170 Game Programming A	2	25	0.5	12.5	12.5	1.0		CPU Lab	900
H172 Portfolio Writing	2	40	0.5	20.0	20.0	1.0		CPU Lab	900
H173 Portfolio Writing A	1	15	0.5	15.0	7.5	0.5		CPU Lab	900
H183 Comp Integrated Manufacturing A	1	9	1	9.0	9.0	1.0		CPU Business Lab	900
		Total Spaces / Day @ 8 periods @ .85 Util				3.4	**4.0**		
English / Humanities									
H201 English I A	8	148	1	18.5	148.0	8.0		Typical Classroom	900
H203 English I C	10	209	1	20.9	209.0	10.0		Typical Classroom	900
H209 Exposit Writ A	1	8	0.5	8.0	4.0	0.5		Small Group Classroom	450
H216 Am. Literature A	4	75	1	18.8	75.0	4.0		Typical Classroom	900
H217 Expository Writing	1	8	0.5	8.0	4.0	0.5		Small Group Classroom	450
H218 Am. Literature C	6	106	1	17.7	106.0	6.0		Typical Classroom	900
H221 Analysis World Lit C	5	91	1	18.2	91.0	5.0		Typical Classroom	900
H222 World Literature A	4	65	1	16.3	65.0	4.0		Typical Classroom	900
H223 Intro Crit C	1	5	0.5	5.0	2.5	0.5		Small Group Classroom	450
H224 Intro Crit A	1	3	0.5	3.0	1.5	0.5		Small Group Classroom	450
H227 AP English	2	36	1	18.0	36.0	2.0		Typical Classroom	900
H229 Creative Writing Wkshop	4	49	0.5	12.3	24.5	2.0		Typical Classroom	900
H229A Creative Writing Wkshop A	2	29	0.5	14.5	14.5	1.0		Typical Classroom	900
H230 Creative Book Transformation	4	65	0.5	16.3	32.5	2.0		Typical Classroom	900
H230A Creative BooK Transformation A	2	20	0.5	10.0	10.0	1.0		Small Group Classroom	450
H252 Introduction to Theater	3	51	0.5	17.0	25.5	1.5		Typical Classroom	900
H253 Playwriting	1	11	0.5	11.0	5.5	0.5		Typical Classroom	900
H255 Short Story & Its Writer C	2	46	0.5	23.0	23.0	1.0		Typical Classroom	900
H260 Modern World Lit. A	2	41	0.5	20.5	20.5	1.0		Typical Classroom	900
H262 Gender In Lit A	1	25	0.5	25.0	12.5	0.5		Small Group Classroom	450
H263 Journalism A and C	1	10	1	10.0	10.0	1.0		Small Group Classroom	450
H264 Film Studies C	10	219	0.5	21.9	109.5	5.0		Typical Classroom	900
H264A Film Studies A	3	25	0.5	8.3	12.5	1.5		Small Group Classroom	450

	Sections	Students	Portion of year?	Avg. Section Size	Seats/ year	Rooms/ year	Rounded up if not shared	Projected Classroom Type	Projected Classroom Size
H265 Advanced Acting A	1	18	0.5	18.0	9.0	0.5		Small Group Classroom	450
H266 Public Speaking C	4	76	0.5	19.0	38.0	2.0		Typical Classroom	900
H266A Public Speaking A	2	22	0.5	11.0	11.0	1.0	6.5	Typical Classroom	900
H267 Improvisation	3	48	0.5	16.0	24.0	1.5		Typical Classroom	900
		Total Spaces / Day @ 8 periods @ .85 Util				9.4	10.0		
World Lanuguages									
H307 French I C	2	24	1	12.0	24.0	2.0		Typical Classroom	900
H308 French I A	2	10	1	5.0	10.0	2.0		Small Group Classroom	450
H309 German I C	2	42	1	21.0	42.0	2.0		Typical Classroom	900
H310 German I A	2	9	1	4.5	9.0	2.0		Small Group Classroom	450
H311 Spanish I C	5	112	1	22.4	112.0	5.0		Typical Classroom	900
H312 Spanish I A	1	25	1	25.0	25.0	1.0		Typical Classroom	900
H313 French II C	2	27	1	13.5	27.0	2.0		Typical Classroom	900
H314 French II A	2	34	1	17.0	34.0	2.0		Typical Classroom	900
H315 German II C	1	15	1	15.0	15.0	1.0		Typical Classroom	900
H316 German II A	1	17	1	17.0	17.0	1.0		Typical Classroom	900
H317 Spanish II C	8	168	1	21.0	168.0	8.0		Typical Classroom	900
H318 Spanish II A	5	131	1	26.2	131.0	5.0		Typical Classroom	900
H319 French III C	1	17	1	17.0	17.0	1.0		Typical Classroom	900
H320 French III A	2	29	1	14.5	29.0	2.0		Typical Classroom	900
H321 Spanish III C	3	64	1	21.3	64.0	3.0		Typical Classroom	900
H322 Spanish III A	6	139	1	23.2	139.0	6.0		Typical Classroom	900
H323 German III A	1	17	1	17.0	17.0	1.0		Typical Classroom	900
H324 Spanish IV C	1	20	1	20.0	20.0	1.0		Typical Classroom	900
H327 French IV C	1	9	1	9.0	9.0	1.0		Small Group Classroom	450
H331 French IV A	1	34	1	34.0	34.0	1.0		Typical Classroom	900
H333 German IV A	1	12	1	12.0	12.0	1.0		Typical Classroom	900
H335 Spanish IV A	3	62	1	20.7	62.0	3.0		Typical Classroom	900
		Total Spaces / Day @ 8 periods @ .85 Util				7.8	8.0		
Health & Physical Education									
H402 Health Ed	14	369	0.5	26.4	184.5	7.0		Typical Classroom	900
H403 Physical Ed	22	552	0.5	25.1	276.0	11.0		Gymnasium	
H404 Physical Ed	2	19	0.5	9.5	9.5	1.0		Gymnasium	
H405 Physical Ed	6	158	0.5	26.3	79.0	3.0		Gymnasium	
H407 Physical Ed.	4	112	0.5	28.0	56.0	2.0		Gymnasium	
H411 Wellness C	14	360	0.5	25.7	180.0	7.0		Fitness Center	1800
		Total Spaces / Day @ 8 periods @ .85 Util				4.6	5.0		

Timberlane Regional High School Curriculum Analysis

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	Sections	Students	Portion of year?	Avg. Section Size	Seats/ year	Rooms/ year	Rounded up if not shared	Projected Classroom Type	Projected Classroom Size
Home Technology									
H501 Child Development	3	64	1	21.3	64.0	3.0		Child Dev Classroom	1200
H503 Adv. Child Development	1	8	1	8.0	8.0	1.0		Child Dev Classroom	1200
H505 Creative Sewing	1	7	0.5	7.0	3.5	0.5		FACS Classroom	1400
H511 Culinary Classics	4	81	1	20.3	81.0	4.0		FACS Classroom	1400
H512 Baking & Pastries	1	9	1	9.0	9.0	1.0		FACS Culinary Lab	1400
H513 Gourmet Foods	1	10	1	10.0	10.0	1.0		FACS Culinary Lab	1400
H525 Designing Homes	1	18	0.5	18.0	9.0	0.5		CPU Graphics Lab	1200
		Total Spaces / Day @ 8 periods @ .85 Util				1.6	**2.0**		
Industrial Technology									
H551 Autocad I	2	10	0.5	5.0	5.0	1.0		CPU Graphics Lab	1200
H552 Autocad II	2	7	0.5	3.5	3.5	1.0		CPU Graphics Lab	1200
H553 Autocad III	2	1	0.5	0.5	0.5	1.0		CPU Graphics Lab	1200
H559 Architectural Drawing	2	16	0.5	8.0	8.0	1.0		CPU Graphics Lab	1200
H577 Wood Tech. I	3	34	0.5	11.3	17.0	1.5		Dirty Lab	1600
H579 Wood Tech. II	1	11	0.5	11.0	5.5	0.5		Dirty Lab	1600
		Total Spaces / Day @ 8 periods @ .85 Util				0.9	**1.0**		
Engineering Technology									
H180 Engineering Design A	1	14	1	14.0	14.0	1.0		CPU Graphics Lab	1200
H181 Prin of Engineering A	1	12	1	12.0	12.0	1.0		CPU Graphics Lab	1200
H182 Digital Electronics A	1	4	1	4.0	4.0	1.0		CPU Graphics Lab	1200
		Total Spaces / Day @ 8 periods @ .85 Util				0.4	**1.0**		
Mathematics									
H601 Math Connections I	1	23	1	23.0	23.0	1.0		Typical Classroom	900
H602 Math Connections II	1	16	1	16.0	16.0	1.0		Typical Classroom	900
H603 Math Connections III	1	28	1	28.0	28.0	1.0		Typical Classroom	900
H604 Topics In Math	3	30	1	10.0	30.0	3.0		Small Group Classroom	450
H605 Algebra I-Part I C	5	80	1	16.0	80.0	5.0		Typical Classroom	900
H606 Algebra I Part II	8	89	1	11.1	89.0	8.0		Small Group Classroom	450
H607 Algebra I A	4	88	1	22.0	88.0	4.0		Typical Classroom	900
H609 Algebra I C	8	162	1	20.3	162.0	8.0		Typical Classroom	900
H613 Geometry A	6	111	1	18.5	111.0	6.0		Typical Classroom	900
H615 Geometry C	9	189	1	21.0	189.0	9.0		Typical Classroom	900
H616 Applied Geometry C	2	103	1	51.5	103.0	2.0		Typical Classroom	900
H619 Algebra II A	6	116	1	19.3	116.0	6.0		Typical Classroom	900
H621 Algebra II C	9	244	1	27.1	244.0	9.0		Typical Classroom	900
H629 Pre-Calculus A	4	91	1	22.8	91.0	4.0		Typical Classroom	900
H630 SAT Prep / Math	2	39	0.5	19.5	19.5	1.0		Typical Classroom	900

	Sections	Students	Portion of year?	Avg. Section Size	Seats/ year	Rooms/ year	Rounded up if not shared	Projected Classroom Type	Projected Classroom Size
H630A SAT Prep Math (11)	1	9	0.5	9.0	4.5	0.5		Small Group Classroom	450
H631 Trigonometry	5	114	0.5	22.8	57.0	2.5		Typical Classroom	900
H632 Prob. & Stats C	4	99	0.5	24.8	49.5	2.0		Typical Classroom	900
H633 AP Calculus	2	27	1	13.5	27.0	2.0		Typical Classroom	900
H636 AP Statistics	1	14	1	14.0	14.0	1.0		Typical Classroom	900
		Total Spaces / Day @ 8 periods @ .85 Util				11.2	**12.0**		
Science									
H705 Physical Science A	5	108	1	21.6	108.0	5.0		Physics/Science Lab	1400
H705BL Physical Science A	8	238	1	29.8	238.0	8.0		Physics/Science Lab	1400
H707 Physical Science C	10	23	1	2.3	23.0	10.0		Physics/Science Lab	1400
H709 Biology A	5	20	1	4.0	20.0	5.0		Biology Lab	1400
H709BL Biology A	2	54	1	27.0	54.0	2.0		Biology Lab	1400
H711 Biology C	11	244	1	22.2	244.0	11.0		Biology Lab	1400
H713 Applied Biology C	1	20	1	20.0	20.0	1.0		Biology Lab	1400
H715 Human Anat/Phys A	3	54	0.5	18.0	27.0	1.5		Typical Classroom	900
H717 Hum. Anat/Phys. C	1	17	0.5	17.0	8.5	0.5		Typical Classroom	900
H721 Environmental Science C	2	38	0.5	19.0	19.0	1.0		Typical Classroom	900
H723 Intro Meteorology C	2	42	0.5	21.0	21.0	1.0		Typical Classroom	900
H727 Chemistry A	4	93	1	23.3	93.0	4.0		Chemistry Lab	1400
H727BL Chemistry A	2	29	1	14.5	29.0	2.0		Chemistry Lab	1400
H729 Chemistry C	7	140	1	20.0	140.0	7.0		Chemistry Lab	1400
H731 Physics A	3	65	1	21.7	65.0	3.0		Chemistry Lab	1400
H731BL Physics A	2	28	1	14.0	28.0	2.0		Chemistry Lab	1400
H733 Physics C	3	65	1	21.7	65.0	3.0		Chemistry Lab	1400
H734 AP Physics	1	20	1	20.0	20.0	1.0		Chemistry Lab	1400
H735 AP Chemistry	1	7	1	7.0	7.0	1.0		Chemistry Lab	1400
H737 AP Biology	3	54	1	18.0	54.0	3.0		Biology Lab	1400
H739 Marine Biology A	3	52	0.5	17.3	26.0	1.5		Biology Lab	1400
H741 Oceanography A	2	42	0.5	21.0	21.0	1.0		Biology Lab	1400
		Total Spaces / Day @ 8 periods @ .85 Util				11.0	**11.0**		
Social Studies / Humanities									
H803 Government Today A	5	120	0.5	24.0	60.0	2.5		Typical Classroom	900
H804 Government Today C	10	268	0.5	26.8	134.0	5.0		Typical Classroom	900
H806 World History A	2	51	1	25.5	51.0	2.0		Typical Classroom	900
H807 US History A	2	56	1	28.0	56.0	2.0		Typical Classroom	900
H808 World Studies C	6	113	2	18.8	226.0	12.0		Typical Classroom	900
H809 US History C	5	107	1	21.4	107.0	5.0		Typical Classroom	900
H811 World History C	5	93	1	18.6	93.0	5.0		Typical Classroom	900

	Sections	Students	Portion of year?	Avg. Section Size	Seats/ year	Rooms/ year	Rounded up if not shared	Projected Classroom Type	Projected Classroom Size
H816 American Studies C	5	88	2	17.6	176.0	10.0		Typical Classroom	900
H817 World Studies A	6	119	2	19.8	238.0	12.0		Typical Classroom	900
H818 American Studies A	5	93	2	18.6	186.0	10.0		Typical Classroom	900
H819 AP US History	1	16	1	16.0	16.0	1.0		Typical Classroom	900
H820 AP Government	1	17	1	17.0	17.0	1.0		Typical Classroom	900
H821 AP World History	1	7	1	7.0	7.0	1.0		Small Group Classroom	450
H826 Economics 9 A	5	121	0.5	24.2	60.5	2.5		Typical Classroom	900
H828 Economics 9 C	10	294	0.5	29.4	147.0	5.0		Typical Classroom	900
H831 Law C	2	37	0.5	18.5	18.5	1.0		Typical Classroom	900
H832 Constitutional Law A	2	17	0.5	8.5	8.5	1.0		Small Group Classroom	450
H835 Sociology C	6	145	0.5	24.2	72.5	3.0		Typical Classroom	900
H839 Psychology C	8	203	0.5	25.4	101.5	4.0		Typical Classroom	900
H841 Am Val Film/Music	1	19	0.5	19.0	9.5	0.5		Typical Classroom	900
H843 Current Issues C	1	28	0.5	28.0	14.0	0.5		Typical Classroom	900
H899 Excel Study	10	38	0.5	3.8	19.0	5.0		Small Group Classroom	450
		Total Spaces / Day @ 8 periods @ .85 Util				13.4	**14.0**		
Special Education / Alternative									
H900 Learning Center	102	524	0.5	5.1	262.0	51.0		Small Group Classroom	450
H960 Reading	5	42	1	8.4	42.0	5.0		Small Group Classroom	450
H962 TEP Algebra I Part I	1	11	1	11.0	11.0	1.0		Typical Classroom	900
H963 TEP Algebra I Part II	1	4	1	4.0	4.0	1.0		Small Group Classroom	450
H964 TEP English I	1	2	1	2.0	2.0	1.0		Small Group Classroom	450
H965 TEP English II	1	3	1	3.0	3.0	1.0		Small Group Classroom	450
H966 TEP English III	1	2	1	2.0	2.0	1.0		Small Group Classroom	450
H970 TEP US Hist	1	2	1	2.0	2.0	1.0		Small Group Classroom	450
H971 TEP World Hist	1	1	1	1.0	1.0	1.0		Small Group Classroom	450
H980 Life Skills I	1	11	0.5	11.0	5.5	0.5		Typical Classroom	900
H981 Life Skills II	1	9	0.5	9.0	4.5	0.5		Small Group Classroom	450
HNN01 Nova Net	5	10	1	2.0	10.0	5.0		Small Group Classroom	450
HOA1 OA Physical Science	1	10	1	10.0	10.0	1.0		Typical Classroom	900
HOA2 OA Algebra I Pt I	1	10	1	10.0	10.0	1.0		Typical Classroom	900
HOA4 OA English 9	1	10	1	10.0	10.0	1.0		Typical Classroom	900
HOA5 OA Govt Today C	1	10	1	10.0	10.0	1.0		Typical Classroom	900
HOA6 OA Economics 9 C	1	10	1	10.0	10.0	1.0		Typical Classroom	900
HOA8 OA Read 180	1	10	0.5	10.0	5.0	0.5		Typical Classroom	900
		Total Spaces / Day @ 8 periods @ .85 Util				11.0	**11.0**		

Timberlane Regional High School Curriculum Analysis

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	Sections	Students	Portion of year?	Avg. Section Size	Seats/ year	Rooms/ year	Rounded up if not shared	Projected Classroom Type	Projected Classroom Size
Flex Space									
HSH09A Lunch / Advisory - 09 F	77	1779	0.5	23.1	889.5	38.5		Cafeteria	6500
Study/Lunch--Seniors	9	595	0.5	66.1	297.5	4.5		Cafeteria	6500
Study/Lunch--Musicians	2	357	0.5	178.5	178.5	1.0		Cafeteria	6500
Study Hall	39	482	0.5	12.4	241.0	19.5		Typical Classroom	900
		Total Spaces / Day @ 8 periods @ .85 Util				9.3	**10.0**	**<--------------Reduce to 2 (cafeteria used for others)**	
Totals									
	Sections	Enrollments		Ave. Section Size	Seats on a yearly basis	Rooms needed/ year			
Overall Totals	795	14001		17.2	10305	555.5			
Per period in 8 period Day	99.4	1750.1				69.4			
		Total Teaching Spaces / Day @ 8 periods @ .85 Util				**80.9**	**86.0**		

Lavallee Brensinger ARCHITECTS

- High School Education Specifications

Timberlane Regional High School

Response to the Educational Specifications

Request of the Architects.

Donald Woodworth, Principal

October, 2008

DRAFT

Section I—Need/Rationale/Process:

A—What are the situations the proposed project will address:

- Increased instructional time
- Ability to implement a more desirable block schedule
- Elimination of current ADA and safety code violations
- Replacement/upgrade of athletic/PE inadequate facilities (locker rooms, storage and indoor teaching space)
- Replacement/upgrade of undersized science classroom space and technology
- Increase in the amount of office and meeting space for administrators
- Creation of adequate storage space for academic departments and building maintenance
- Elimination of modular classrooms being used for regular and special education
- Relief from the current 98% classroom usage
- Upgrading/modernization of the bathroom facilities to meet ADA requirements
- Improved efficiency of the traffic flow on the HS/MS/PAC campus
- Increased number of parking spaces for staff and students
- Replacement of the antiquated intercom system
- Irrigation of the practice fields
- Repair of some portions of the roof
- Replacement of the 1966 windows for increased efficiency
- Upgrade of the current media center to meet 21st Century student needs
- Complete upgrade in building technology to current standards
- Specially designed space for students with Autism Spectrum Disorders
- Expansion of the cafeteria to meet the desired one-third ratio
- Creation of larger indoor gathering space for students and staff
- Upgrading of the Cooking classroom
- Redesign and upgrade of the current home technology classroom to meet current teaching curricula
- Increase in the number of indoor teaching spaces for PE and practice facilities for Athletics
- Increased amount of natural lighting
- Vastly improved heat efficiency
- Complete overhaul of the heating system to create a comfortable environment in all classroom during colder months
- Upgrade of classroom access to and availability of all types of educational technology

B—What alternatives were considered to the solution chosen?

Over the past ten years, modular classrooms have been purchased, the schedule has been expanded and class time shortened, department offices have been combined, closets and bathrooms have been converted into offices, and class sizes have been maximized in some subjects to fit into the building and to maintain current delivery of the curriculum. A new wing of the high school opened in 2001, as did renovated classrooms and the performing arts center. However, growth in school population and growth in school programs such as special education and engineering have exceeded the capacity created by that renovation. **At this point, the**

decision is to pursue either new construction or reconstruction. Renovation is ongoing in order to maintain our present delivery methods and curriculum. The non-construction options range from extending the school day to double sessions.

C— What methodology was employed to the solution chosen?

The current solutions to space issues are based on immediacy of need. To add a class or expand a program during the school day necessitates taking away some other scheduled class or reducing the scope of another program. The New England Association of Schools and Colleges (NEASC) self-study and ensuing visitation provided survey information, community, SAU, teacher, student, parent and administrative feedback on all aspects of the high school. In addition, NESDEC was hired to assess the present conditions of the high school and middle school. The district facility committee, curriculum committee and safety committee have provided further input on facility needs to accommodate instruction and use of the building.

D— What are the characteristics of the community or region the project is proposed to serve?

The district is comprised of four rural/suburban towns: Danville Atkinson, Plaistow and Sandown. One 6-8 middle school feeds the high school. The towns are situated in southeastern NH along the Massachusetts border. The school is in Plaistow, 34 miles from Boston, MA, 28 miles from Manchester, NH and 40 miles from Portsmouth, NH. The Plaistow and Atkinson border the city of Haverhill, MA.

The community demographics have been detailed in recent NESDEC and NEASC reports. They reveal that the district has struggled to keep pace with the facility needs of aging buildings through renovation and maintenance.

Section II—The People and Program to be Housed

A—Enrollment/Teachers:

Future student enrollment numbers vary widely, depending on the source of information used. The NEASC report speculated on continued but slowed increases in student population, while reports from NESDEC point to a steady decrease into the mid-1,200's. NESDEC did note that their projections were made during the current housing decline, and that a rebound in the market could drastically change the future numbers. The following numbers reflect a student population remaining at the current 1,600.

TRHS currently has 106 classroom teachers. Assuming the population of the school remains level, that number should also.

NESDEC has given us a report laying out the 'Current Operating Capacity' of the current facility (COC). This has been the driving document for what follows in this section.

B—Organizational patterns:

TRHS is organized as most high schools in this area, with grades 9-12 housed almost entirely in one building. Students normally accrue credits over a four year period, with all grades co-existing in the same building for almost all of their classes. Students taking classes in the performing arts do leave the core high school building and attend classes in the performing arts center. Regardless of the schedule chosen in the future (eight periods or four blocks), the entire student body will transition from period to period at the same time.

C—Activity areas needed:

Given the current 98% capacity of the present facility (including the four modular classrooms), it is virtually impossible for new and innovative programs to get off the ground. Schools of similar size and financial support in New Hampshire and northeastern Massachusetts have been able to add many additional programs. What follows is a *partial* list of programs that would be part of a true 21st century high school:

- Engineering Design, Fabrication and Robotics lab to replace the current use of a wood shop.
- Journalism/writing labs which currently exist only if business computer labs are available
- Writing and math resource centers that provide accessible student support to the entire student population.
- Science laboratory classrooms that provide space and support technologies for student experiments, activities, and project work.

- Video production facility to support student work, and create a student video production class
- Fitness center for student/staff use, connected with science (biology-kinesthesiology) nutrition/cooking facility and training room(s).
- Addition of another viable teaching space for physical education—space that may also be used for athletics in the afternoon
- Flexible humanities teaching space to allow for more student-centered and effective teaching through the use of combined, heterogeneously grouped classes
- Centralization of the media center, department offices, administrative offices, student lockers, and presentation areas to highlight quality student work.
- Child Development lab to support experiential learning with the current child development classes
- Fashion Merchandizing/Interior Design lab to update traditional sewing and room design courses.
- Graphic Design and Marketing lab to replace/enhance the current marketing classes and provide real-time application experiences that would service the school and community
- Updated professional kitchen facilities with separate conference/restaurant seating capacity for 30 to support culinary technology courses and current staff needs for a meeting room and onsite professional development.
- School Store close to gym entrance and cafeteria access that focuses on student management with accounting/entrepreneurial students managing and SpEd students learning focused job skills. Provide an outlet for student spirit and class fundraising….consumer tech sales.

Assuming the current enrollment numbers level off, and the desire is to get to a capacity of about 80% of maximum, the following is a list of what would be needed to simply maintain current programming, while bringing certain spaces up to current standards (science), while adding a real TV studio space.

Future/Desired	Change	No. of Rooms	Stud. Stations (each)	Total Capacity
Gen. purpose classrooms	add 8	43	24	1032
Art Rooms	add 1	4	24	96
Bus/Computer rooms	add 1	5	24	120
FACS rooms/meeting space	add 2	4	20	80
Tech Ed. Rooms	level	1	18	18
CAD/CAM Rooms	add 1	2	24	48
Drama	level	1	25	25
Band/Chorus/Orchestra	level	3	27	81
PE/Health	add 2	6	25	150
Science Rooms/Labs	add 6	17	24	408
TV Studio	add 1	1	15	15
				2073
			Use @ 80%	1,658

A new/renovated school would need all the above classrooms, plus the following to implement some of the desired programmatic changes outlined elsewhere in this report:

- An additional full-sized gym, or creation of a gymnasium large enough to accommodate three distinct teaching spaces and two athletic practices simultaneously, and approximately 1,500 spectators in seats. This assumes a mini-gym is included as well.
- Two additional meeting spaces for groups of staff/students up to approximately 18 people at a time in a non-classroom setting. One of these might be the culinary seating/meeting/conference room.
- Multiple storage facilities. At a minimum, a storage room for each department, including guidance, the front office, special education, and other related programs and services.
- The complete renovation and/or modernization of the student and staff!!!! bathrooms.
- An addition of at least two practice/PE fields. This could include the installation of state-of-the art artificial turf to the stadium, which would allow its use all day long.
- A sizeable expansion of the media center, one that allows it to become both useable by many more students at one time, but puts it at the center of the learning community. In a new facility, this should be at the center of the building as both a functional and symbolic center of the learning process.
- The addition of three multi-purpose, state of the art computer labs.
- More appropriate space for students with Autism-Spectrum disorders, including private bathroom facilities, and provisions for related services in that space.
- An expansion or replacement of the cafeteria to bring it up to the recommended capacity of about one-third of the student body.
- The creation of two regular-education learning centers—One for math/science/technology, the other for the humanities. Adjacent to the media/library center for access by all students.
- A more size-appropriate and private training room.
- An engineering and robotics design and fabrication space allowing space for 21st Century work.

C—Characteristics of space needed:

Each of the standard classroom spaces outlined in the above chart will need to (ideally) be set up as a modern classroom. Humanities classrooms will need increased floor space, secure storage, multiple electric outlets, LCD projectors permanently connected to SmartBoards, and wireless networking. Since teachers in these disciplines will sometimes be working with multiple classes at a time, some provision for double classes should be made. Science and math classes (not science labs) will need the same, plus space for demonstrations and/or activities by students. Science labs should be designed as specified by nationally-recognized design specs and include storage space for larger instruments, equipment, and student project design. Math rooms should have as much white board space as possible with ongoing access to wireless computers. PE classrooms (including the 'big' and 'mini' gym) should be able to be individually customized/divided so that students can choose from a variety of activities at one time. The Consumer Technology rooms should be designed to most appropriately match current curricular trends, including vastly increased storage space, modern equipment, and purposeful space for the experiential and application requirements of their work. Special Education learning center classrooms should be smaller than regular education rooms, and include flexible yet private student work space, accommodations for multiple teachers and paraprofessionals. The norm would be for two teachers to share a space about 75% the size of a regular education classroom. Accommodations for these rooms to be as quiet as possible should be included. Computer labs will also need LCD projectors and SmartBoards, and be aligned for maximum supervision by the teacher. Other special spaces should be designed to be as flexible as possible, as future needs simply cannot be fully anticipated at this time.

All classrooms should be designed to meet the specifications that exist from national organizations, department of education standards, and other recommendations. Ideally, no classroom will be isolated such that it has no way of seeing sunlight in some way, be it through a direct window, or a skylight in the hallway/atrium area. All rooms must have effective air ventilation and conditioning systems (but not necessarily full cooling capacity). As possible renovations should include green and sustainable practices that increase energy efficiency and resiliency.

Recent trends in education have teachers and students working in cross-curricular partnerships much more than in the past. As such, purposeful alterations in the structure should support teachers and students in related disciplines (the humanities, math/science/ technology, phys.ed / nutrition) together at one time. As such, it is desired for those departments to be clustered together as much as possible. Three clusters are envisioned:

- Math, Science, Technology (including Consumer Technology) and other related classes
- Physical Education, athletics and other related classes adjacent to the science group.
- Social Sciences, English, World Languages, Art, Performing arts and other related classes

It is preferable that there be a centrally located office space for special education, but that the learning center rooms be consciously de-centralized. There should <u>not</u> be a special education 'wing' or area of the building, or anything resembling that. Math, science and humanities support labs should be adjacent to the media center and in close proximity to special education Learning Center classrooms.

The main entrance to the new space should be welcoming, and easily guide visitors to administration offices, the guidance suite, the special education parent/teacher/student meeting area, and other commonly visited space. This area should be open as much as possible with presentation displays of student accomplishments to present the school in an appealing way. Security should be considered, so that visitors will have to pass a simple yet effective barrier to entrance during the school day. The school resource officer's office should be in this space, but private and secure. The officer cannot act as the gatekeeper to the building but should be accessible to administration and the reception areas.

The working or facility support side of the building (custodial area, food service, deliveries, etc.) should be away from student space as much as possible, with controlled access. The number of entrances to the building should be limited as much as possible for security reasons. Public spaces should be set up for maximal coverage by security cameras, and all doors should utilize a pass-card system of access, allowing for access to be customized. The security system and PA system should include two-way communications between security system arming panels and the building. The cafeteria kitchen should be as close to the consumer technology/kitchen space as possible.

Outside the building itself, there is a need for additional field space for PE and athletic practices. If the footprint of a new building eliminates such space, that adds even more to the requirements of the project. The current school has parking for only staff and seniors, plus about thirty juniors per semester. It is desired for that number to increase, particularly to allow more juniors with after school co-curricular activities to park on campus. We will need about 150 more spaces for that purpose.

Size requirements for rooms (general).

- Offices: 125 ft^2
- Classrooms: 1,100 ft^2
- Science labs: 1,200 ft^2
- Learning Centers: 800 ft^2
- Various other sizes TBD, depending on design

Section III – General Building Considerations

A—How will the building provide for the future needs and flexibility for program changes and additions?

A reconstructed or new building will provide much needed purposeful space for program development and improved instruction. As the school programs become more coherent and coordinated, the facility design must facilitate movement between linked courses and programs. We seek to improved proximity of linked departments, student access to the library/media center, enclosed and convenient access to the performing arts center, easy access to the cafeteria, a central location of the nurse's station and the overall need for spacious gathering areas, and presentation areas. Expanded curricular offerings in such areas as science, technology, engineering, and robotics necessitate additional classrooms and technology. The size and design of the PE/Health/Athletics wing limits instructional options and program growth. A new facility must address this need. In addition, all areas of the building must be handicapped accessible.

B—What is the plan for community use of the facilities? How will the building accommodate these plans?

The building and performing arts center are available for community use after school hours and during evening division hours. The PAC is often rented and all facilities are available as needed and when not in use on a first come-first serve basis through a formal facility use sign up process. The rest of the building (classrooms, athletic facilities, cafeteria) will continue to accessed by the community. Ideally, the areas of the building used by community groups or for athletic/performance events will be situated to secure the classroom space of the building 'after hours'.

C—What special provisions will be made to ensure the health and safety of the building's occupants?

The hallways will be wider, handicapped access will be improved, hallway signs will be made visible and the nurse's station will be larger and more accessible. The intercom system will be improved, and connected to the telephone system. Security cameras will be installed as needed. All rooms will be uniformly keyed and access from outside will be controlled with an automatic door locking system. Rooms will be equipped with a means to block vision into the rooms with either blinds, shades or other means.

D—What building-wide security requirements are planned? What effect will they have on the occupants of the building?

See section "c." The occupants will be protected by a state-of- the- art security system, that includes cameras, automatic locking of outside doors , an effective building –wide communications system, and a one-master key door locking system.

E—What building-wide communication and technology requirements are proposed?

Rooms will be equipped with wireless computers for student and teacher use – a combination of laptop and desktop computers. Teachers will have telephone access in each room. Video capability will be built into all instructional areas and in gathering/presentation areas. All areas of the building and PAC will share the same communication system.

F—What is the extent to which the building will be "green"?

At every turn of the renovation project(s) we should be looking for energy efficiency. This can only improve the "greening" of TRHS which was constructed before there were energy-related or sustainability-related concerns. We should look towards recyclable materials for construction, furniture and casework. Solvent-free coatings should be used as our budget permits. Use of natural lighting and air cycling should be a priority as much as possible.

G—What will be the characteristics of the maintenance plan? Will it be based on life cycle analysis? Will there be provisions for commissioning and for the training of maintenance personnel? Will total cost of ownership be considered? Will the project cause a need for additional maintenance staff?

The maintenance plan should be based upon the life cycle of materials chosen. Efforts should be made to purchase quality materials that eliminate repeated fixes to furniture or casework. Where possible the casework should have a minimal install to allow for flexibility and possible classroom transitioning. The project should not increase the maintenance staff but provide for easy cleaning and robust usage by high school students.

H—What provisions will be made for building access, based on the activity area groupings, pedestrian and vehicle traffic patterns, community usage, handicapped accessibility and site constraints?

The building should be designed with no more than three major entrances: front office, bus drop-off, and sporting/performance events. These areas should have handicapped accessibility with automatic doors and ramps for wheelchairs etc. This should also minimize security needs. Additional exits should provide for rapid evacuation and also have characteristic ramping for handicapped individuals to exit safely. Traffic patterns should separate major bus drop-offs with the main entrance of the building where students arriving by car can be dropped off/picked up. Adequate parking for visitors to the main office and staff should be adjacent to the building. Separate access for large deliveries should be positioned closes to the maintenance area and cafeteria.

Section IV—Site Considerations

Preface: This section is written under the assumption that a new building will be constructed very close to the current building to allow continued and convenient access to the Performing Arts Center, which will continue to act as the primary teaching space for the performing arts.

A—Size:

The current site of the TRHS/TRMS/PAC/SAU campus is approximately 90 acres, of which only about 40 are cleared and in use. As such, there is more than enough space to meet current and future needs.

B—Advantages/Constraints:

The Timberlane Performing Arts Center (PAC) was opened in 2001, and should remain an integral and accessible part of the TRHS facility. Land that is close enough to the PAC to make construction feasible is flat, and appears well suited for new construction. There was an issue during the construction of the newest wings of the current high school and middle school. The soil under the newest wings of both schools had to be extensively compacted due to the instability of the underlying base layers, and that may occur again with the new location. Construction in this area closest to the PAC will eliminate much of the PE/Athletic practice space of the high school, and some of the middle school's as well. This will necessitate the clearing/preparation and construction of new practice space in what is now woodland south of the current practice area(s).

C—Issues to Address:

The land proposed for the new building is owned by the school district, as is enough land to construct new PE/practice fields to replace those lost under the new building/parking.

There is currently a significant traffic problem accessing the HS/MS campus in the morning, and a slightly less troublesome issue in the afternoon. It may be possible to construct a new access road to the campus from the southwest, connecting campus to East Road in Atkinson. The same may be possible to NH Route 125 in Plaistow to the southeast. Placement of the new building will need to be done so as to allow bus traffic to move efficiently around the buildings, while maintaining access to the PAC, service entrances of the new and present buildings, and safety considerations. As stated in other parts of this report, provisions need to be made for at least 20% more parking spaces, ideally situated to service multiple gathering points on the campus, in particular the athletic facilities.

There is not a need for playground space, and (as previously stated) sufficient room for expansion/replacement of the athletic/PE fields to be lost.

TRHS does not receive students from other schools on a daily basis, but does send students to two vocational centers. This is done at present from the current facility, so this is not a problem created or exacerbated by the construction of a new facility.

The topography of the site is quite good. The land is flat, but the condition of the underlying layers is unknown, making development costs difficult to estimate. There was a fairly recent dig in the area to bury the 12,000 gallon sprinkler tank, which was not problematic, and may help determine the quality of the underlying layers in that area. That tank, however, may lie directly under the proposed facility.

It is unknown how many students walk/bike to school every day, but the number is a small percentage (<5%) of the population. Many arrive by car.

Utilities in the area are adequate, but the addition of a new school may necessitate an upgrade of some electric lines. The lighting of the stadium field in the fall of 2,000 required a new transformer at the street level. Water currently comes from a well, and the current schools share a leach field out back (also close to the proposed school site). Internet service to the campus, and fiber-optic lines connecting the four buildings (including the SAU office), can be easily converted over to a new building.

As the site of the new school is just behind the current school, zoning/planning should not be an issue.

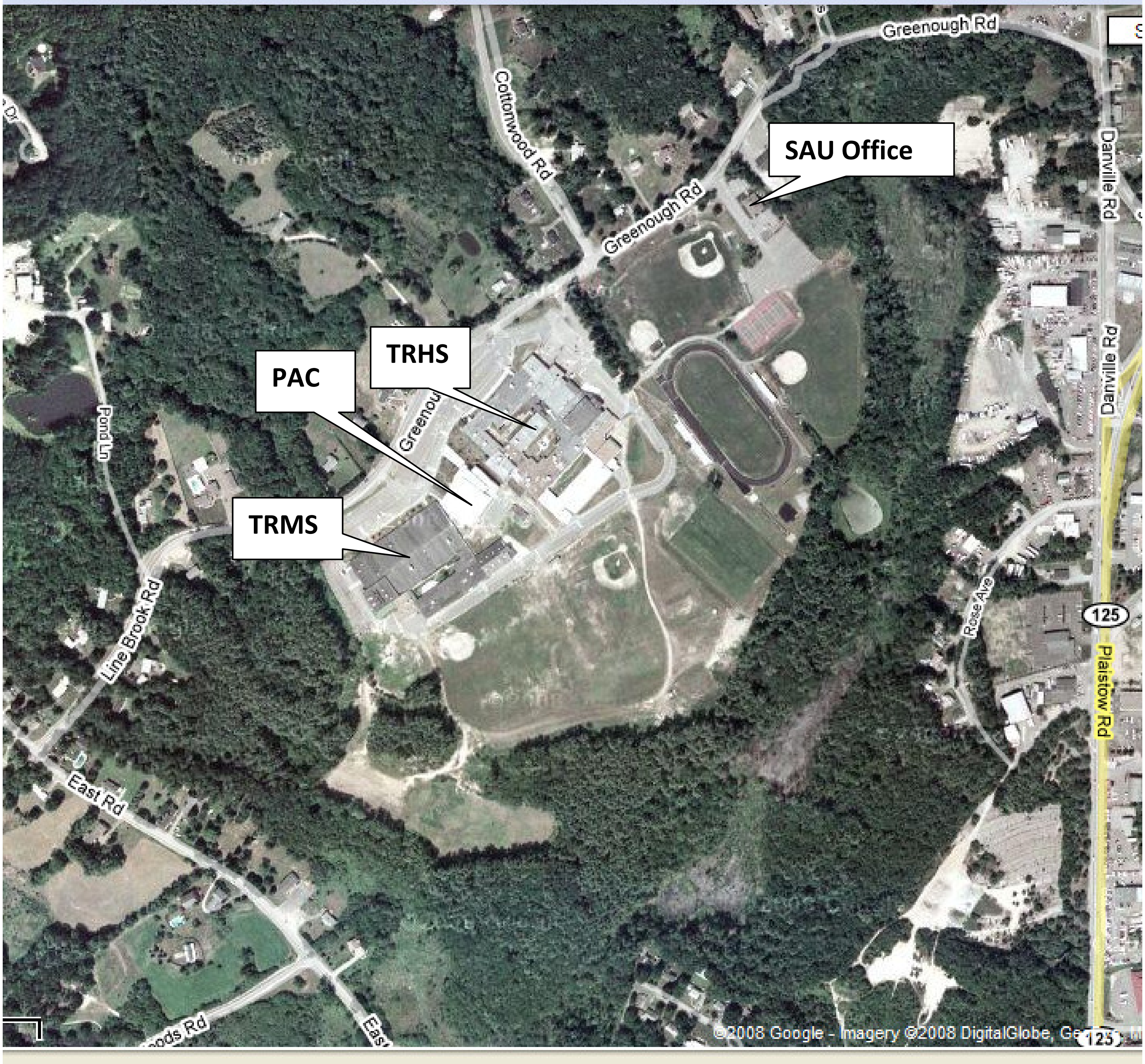
As stated previously, there is much buildable land beyond the ‘tree line’ at the back of the school property for future expansions if necessary.

D—Plan relative to A and B:

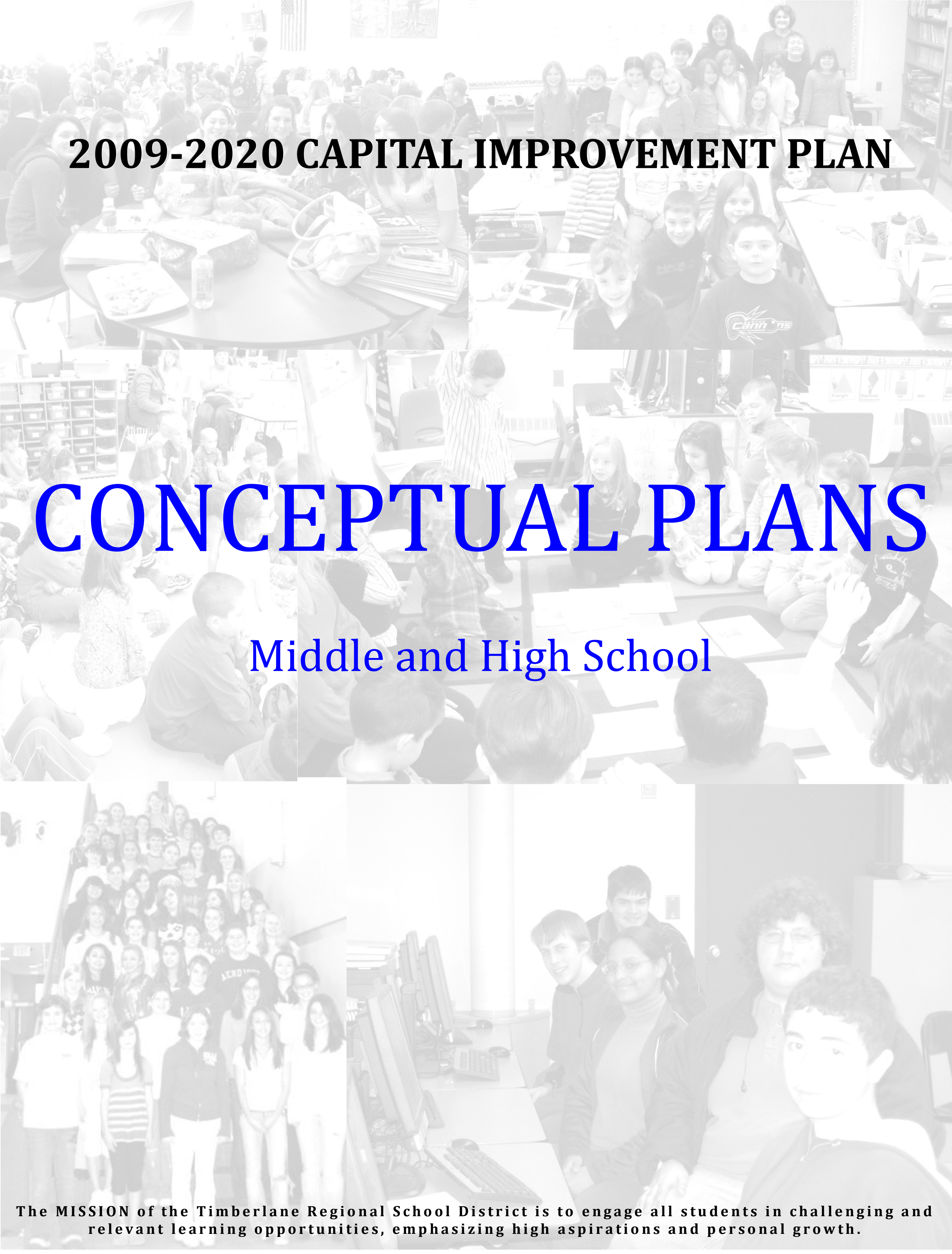
As is fully explained above, the site proposed does is adequate for the plan as currently envisioned.

TRHS/TRMS/SAU Campus

Map Source: maps.google.com




Greenough Rd



2009-2020 CAPITAL IMPROVEMENT PLAN

CONCEPTUAL PLANS

Middle and High School

The MISSION of the Timberlane Regional School District is to engage all students in challenging and relevant learning opportunities, emphasizing high aspirations and personal growth.

TIMBERLANE REGIONAL SCHOOL DISTRICT (SAU 55)

Conceptual Diagrams

Existing Overall Site Plan

Lavallee Brensinger ARCHITECTS

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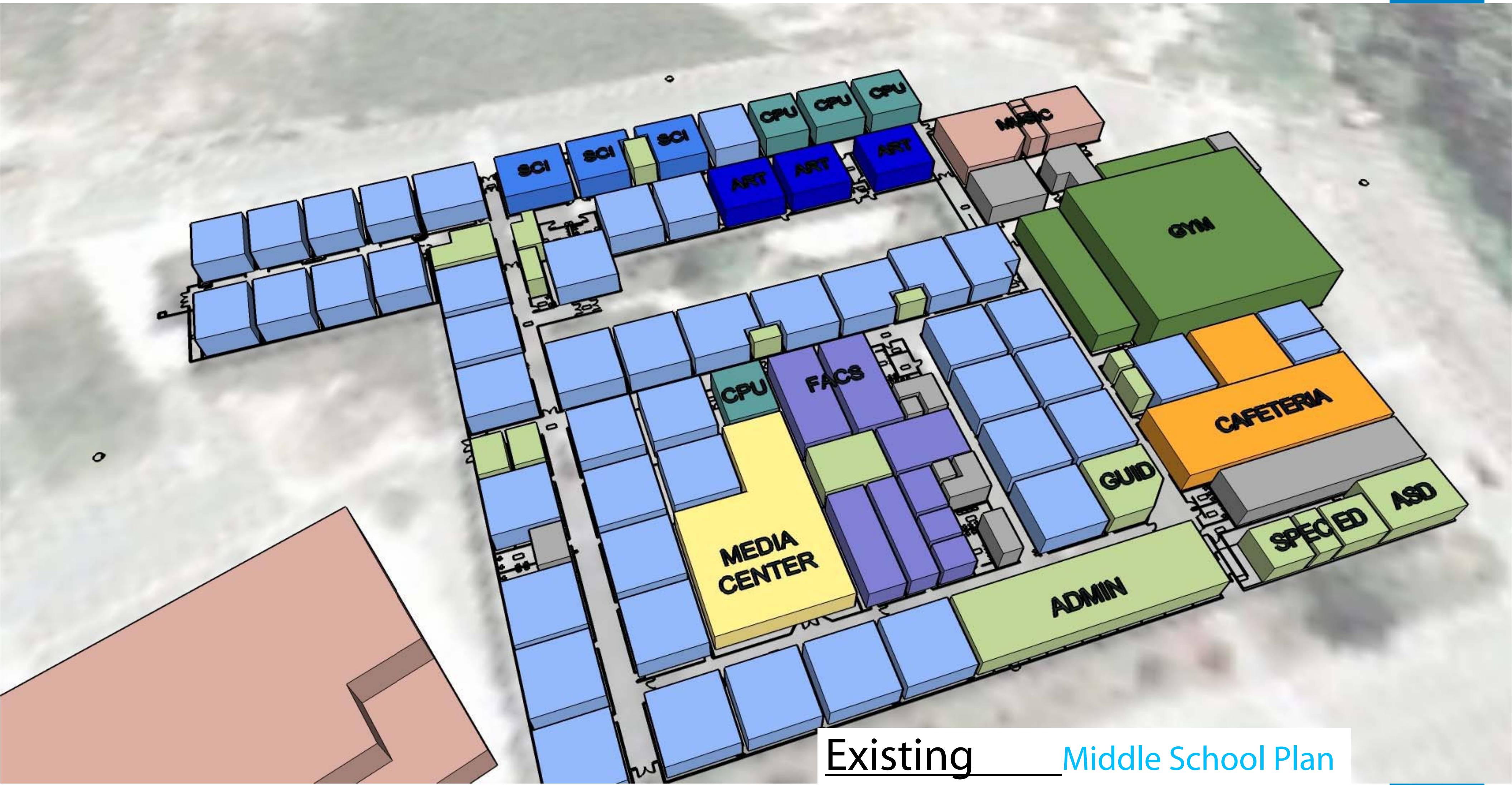
Conceptual Diagrams

Existing High School Plan

Conceptual Diagrams



Existing Middle School Plan

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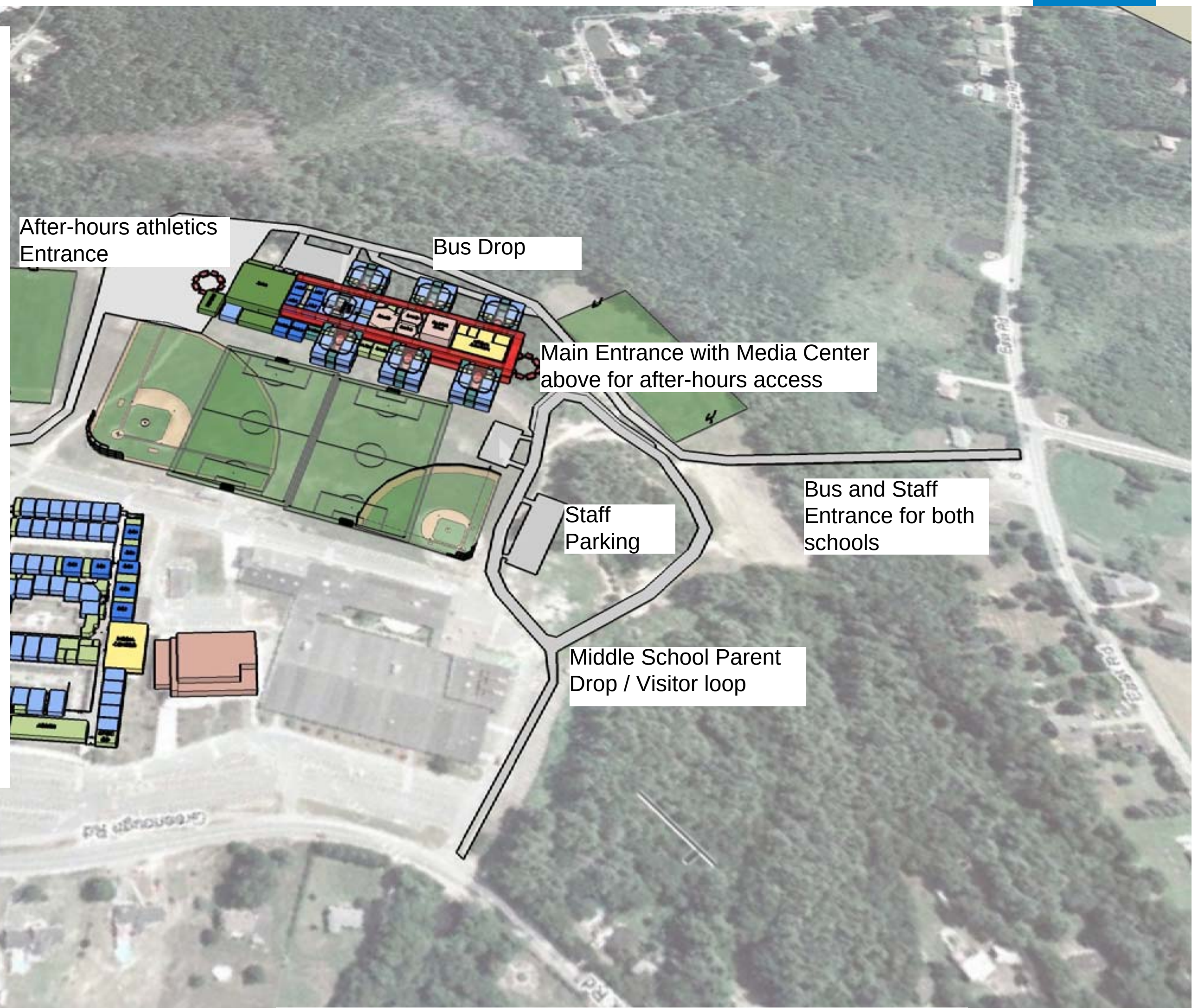
Scheme A Talking Points

-New 2 story Middle School located on existing property. Placed on flat area behind ball-fields. Second access from East Road shown. Design concept is Core Spaces in center with Education Areas flanking either side.

-Pro: Access off East Road would improve congestion. (If access not obtained from East Road, scheme is still viable, however, site issues will remain).
-Pro: Layout allows for no through-travel in Pods
-Pro: Fairly compact design (partially due to site constraints)
-Pro: Allows HS to remain with PAC
-Con: Does not add athletic fields
-Con: Very Tight site design (ball-fields very close to new building)
-Con: Allows for very limited growth of core areas in future
-Con: Limited natural light to first floor core areas.



Scheme A Overall Site Plan

Conceptual Diagrams

Scheme A Overall Building

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Conceptual Diagrams

Scheme A First Floor Plan

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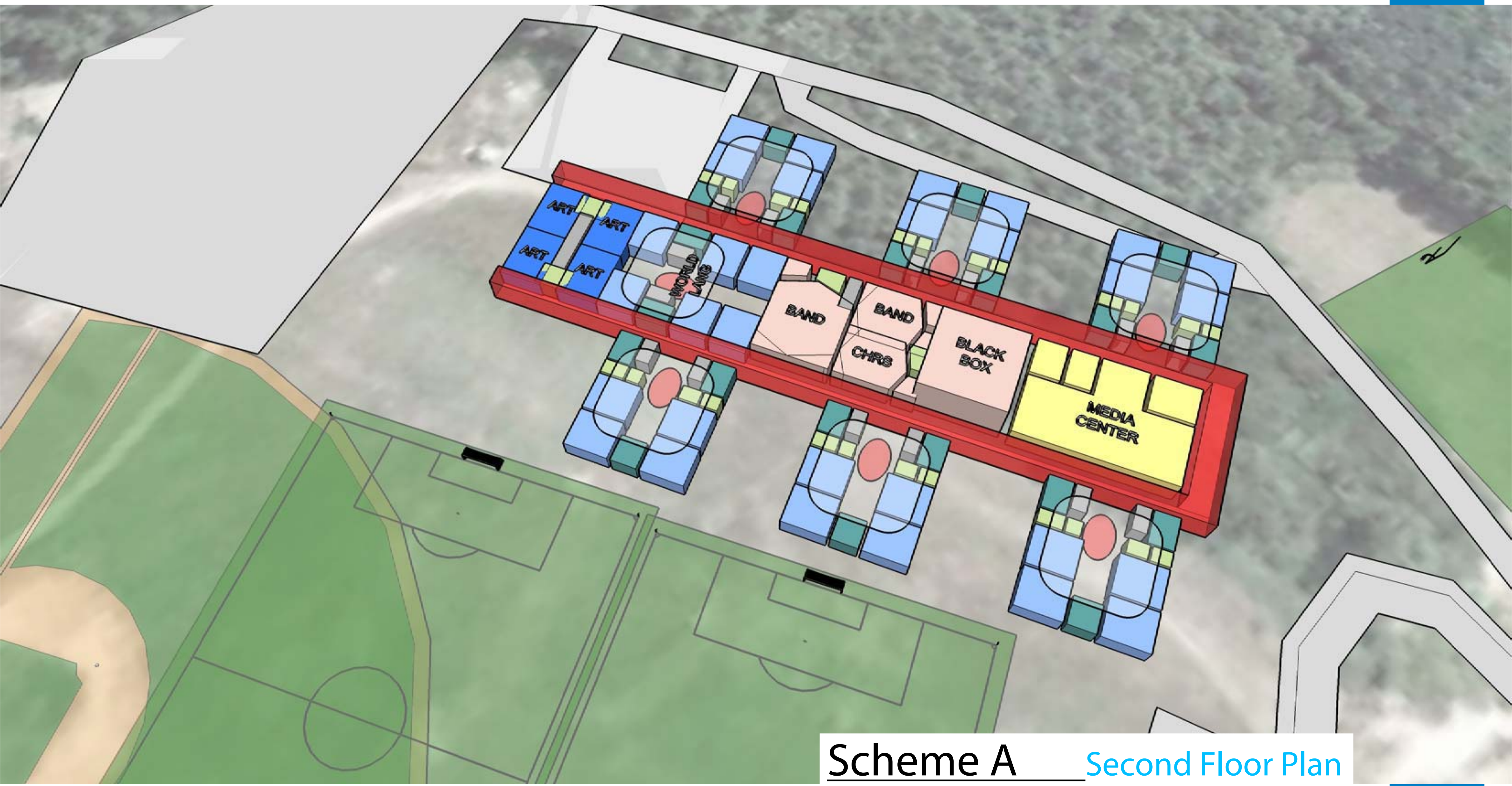

Scheme A Second Floor Plan

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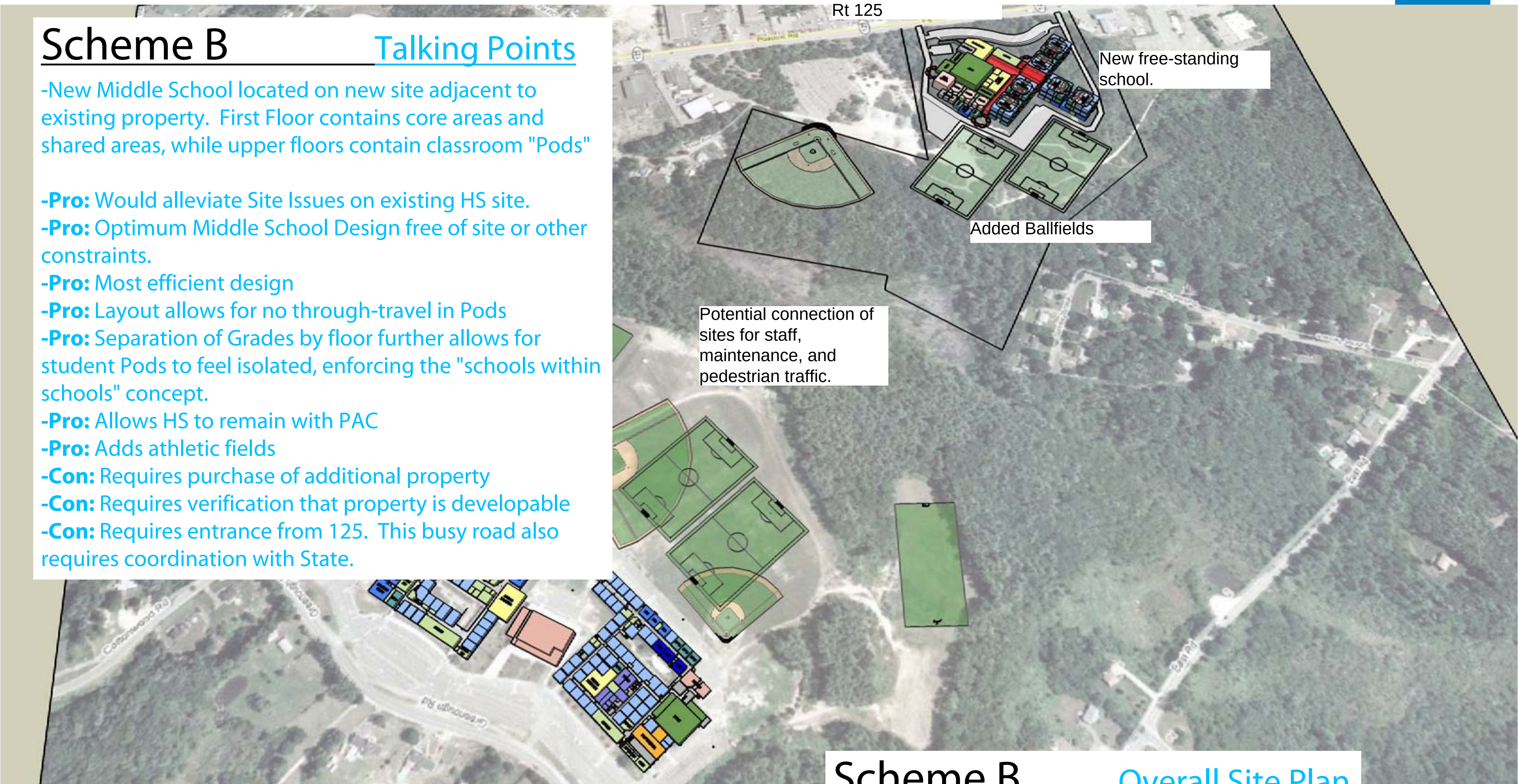
Conceptual Diagrams

Scheme B Talking Points

-New Middle School located on new site adjacent to existing property. First Floor contains core areas and shared areas, while upper floors contain classroom "Pods"

-Pro: Would alleviate Site Issues on existing HS site.
-Pro: Optimum Middle School Design free of site or other constraints.
-Pro: Most efficient design
-Pro: Layout allows for no through-travel in Pods
-Pro: Separation of Grades by floor further allows for student Pods to feel isolated, enforcing the "schools within schools" concept.
-Pro: Allows HS to remain with PAC
-Pro: Adds athletic fields
-Con: Requires purchase of additional property
-Con: Requires verification that property is developable
-Con: Requires entrance from 125. This busy road also requires coordination with State.



Scheme B Overall Site Plan

Conceptual Diagrams

Scheme B Overall Building

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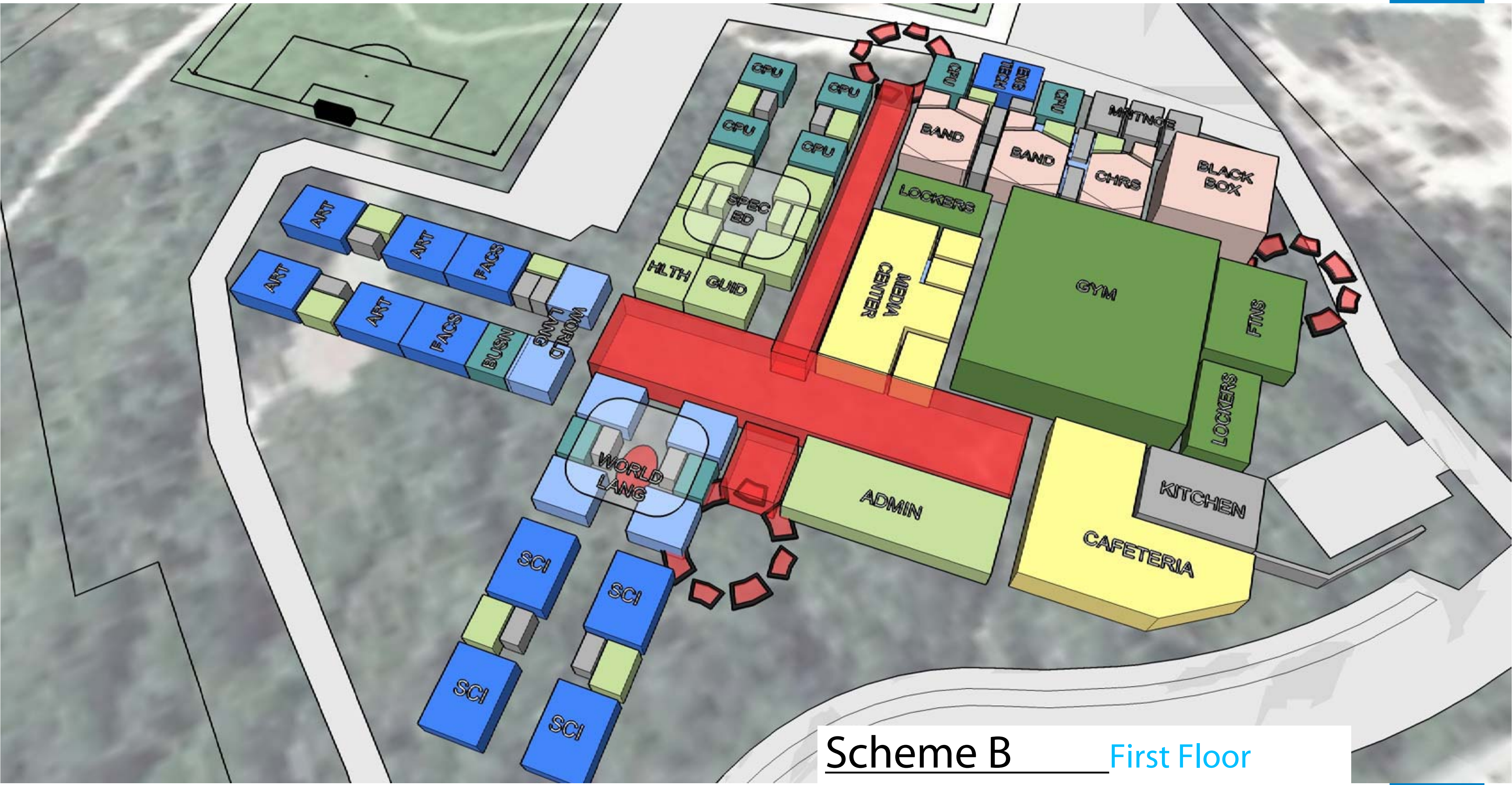
Conceptual Diagrams



Scheme B First Floor

Conceptual Diagrams

Scheme B Second Floor

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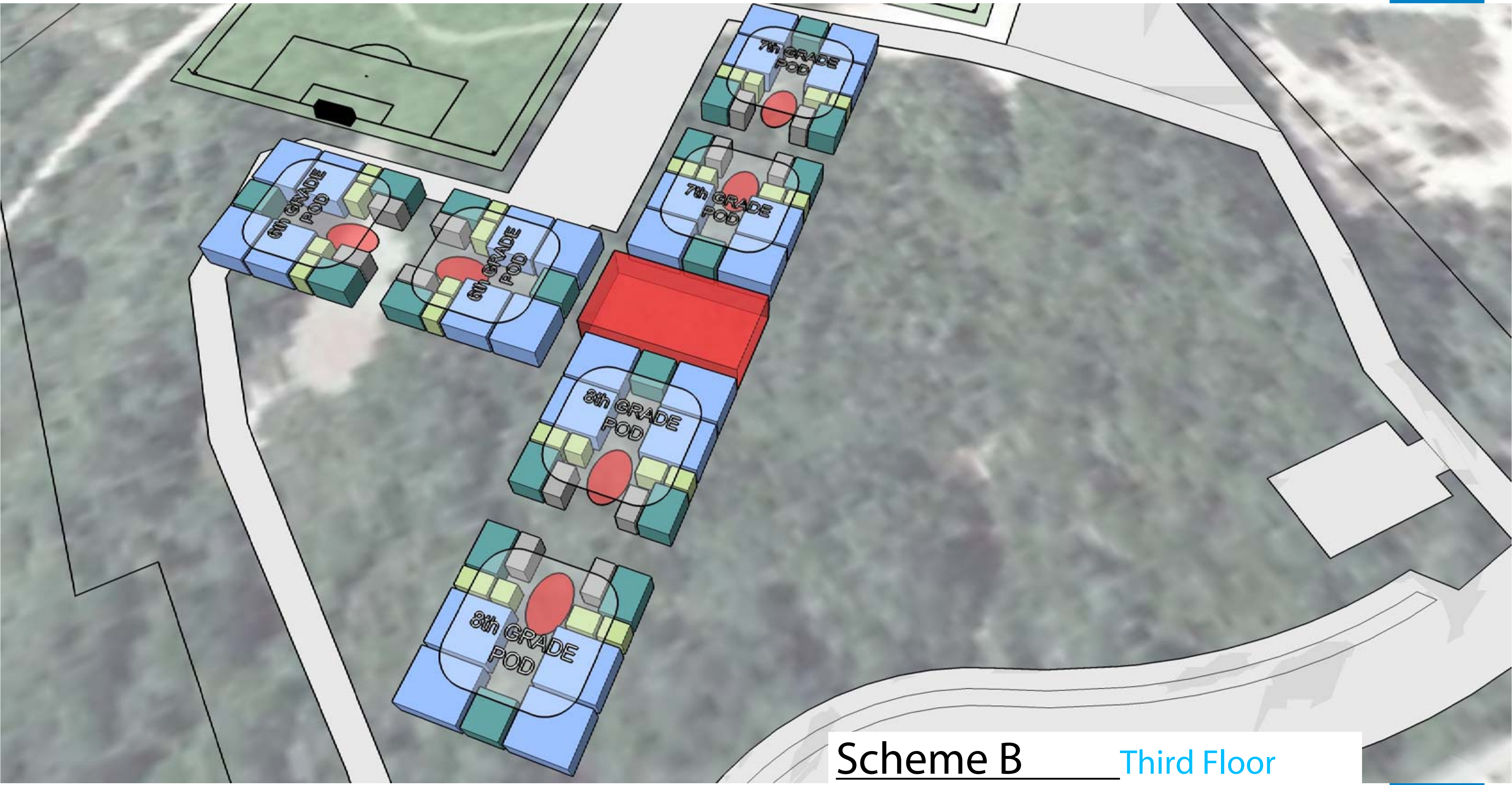

Scheme B Third Floor

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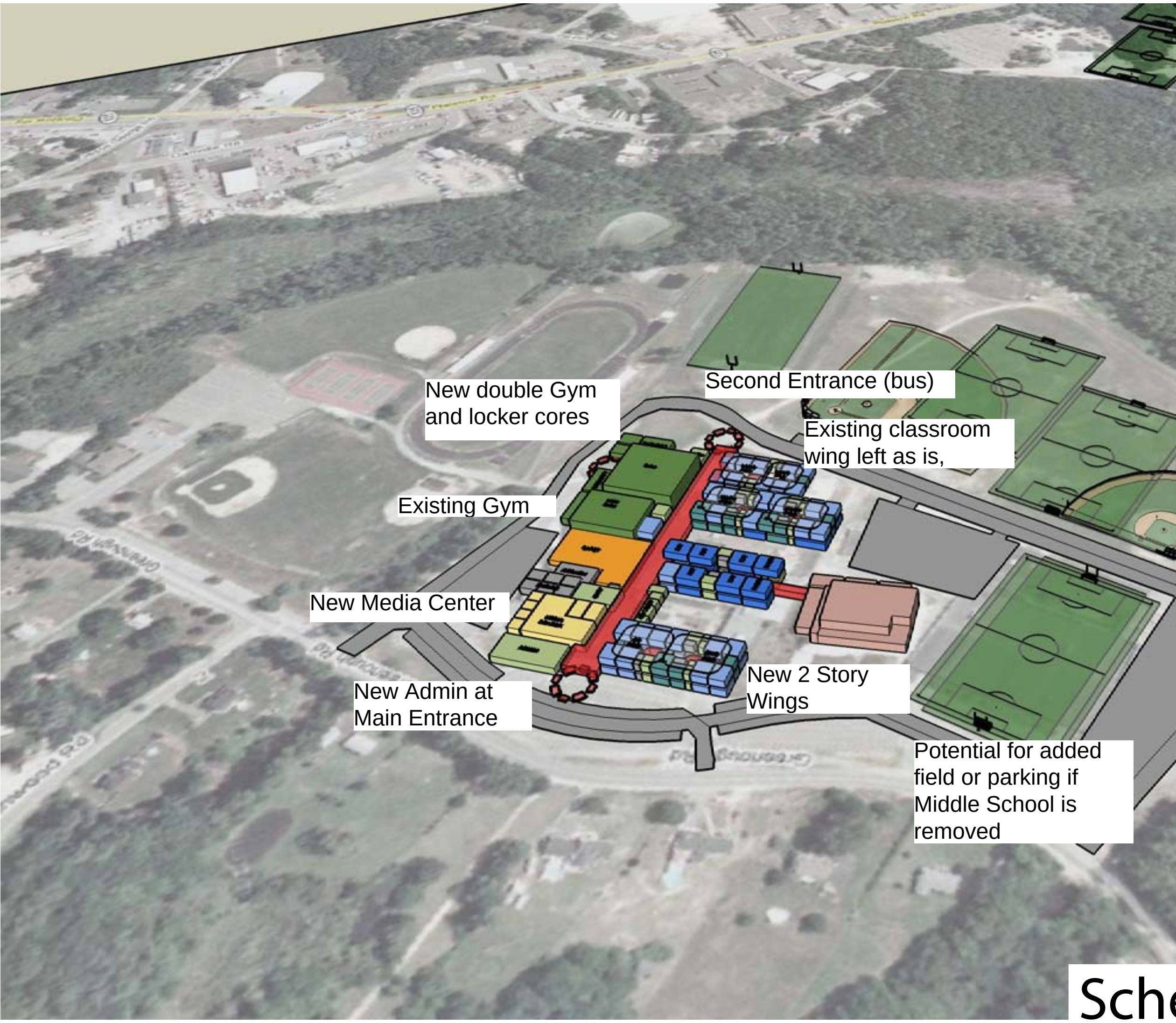

Scheme C Talking Points

-Reconstruction of HS Building into New High School. Replaces all education areas with 2 Story Classroom Wings. Renovates and re-uses Cafeteria, Gym, mechanical areas, and newest classroom wing.

- **-Pro:** Creates all new education spaces suitable for 21st century education.
- **-Pro:** re-uses some areas
- **-Pro:** Connects High School to Performing Arts Center
- **-Pro:** Reorganized building to "Main Street" Concept
- **-Pro:** All departments have a face on "Main Street"
- **-Pro:** Resolves all issues with existing building.
- **-Pro:** Integrates Guidance and Special Education into education areas
- **-Con:** 2 stories requires 4 wings, which gets very tight for proper sunlit courtyards
- **-Con:** Eliminates newly renovated Science Labs
- **-Con:** Requires DOE permission given that will exceed 60% of new building cost.
- **-Note:** Requires new middle school and second access to address site issues.

Scheme C Overall Site Plan

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Conceptual Diagrams

Scheme C Overall Building

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Conceptual Diagrams

Scheme C Existing to Remain

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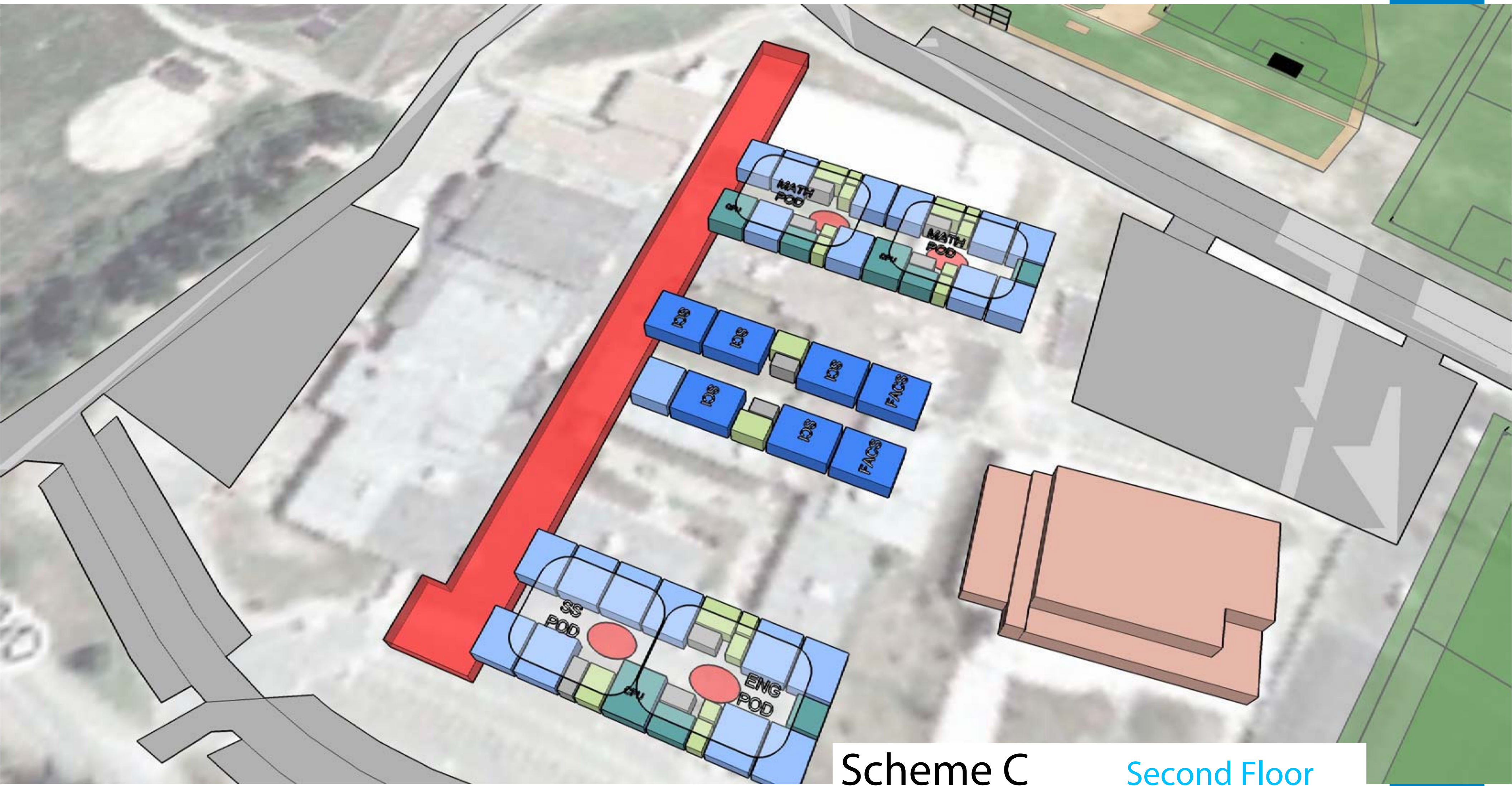
TIMBERLANE REGIONAL SCHOOL DISTRICT (SAU 55)

Conceptual Diagrams

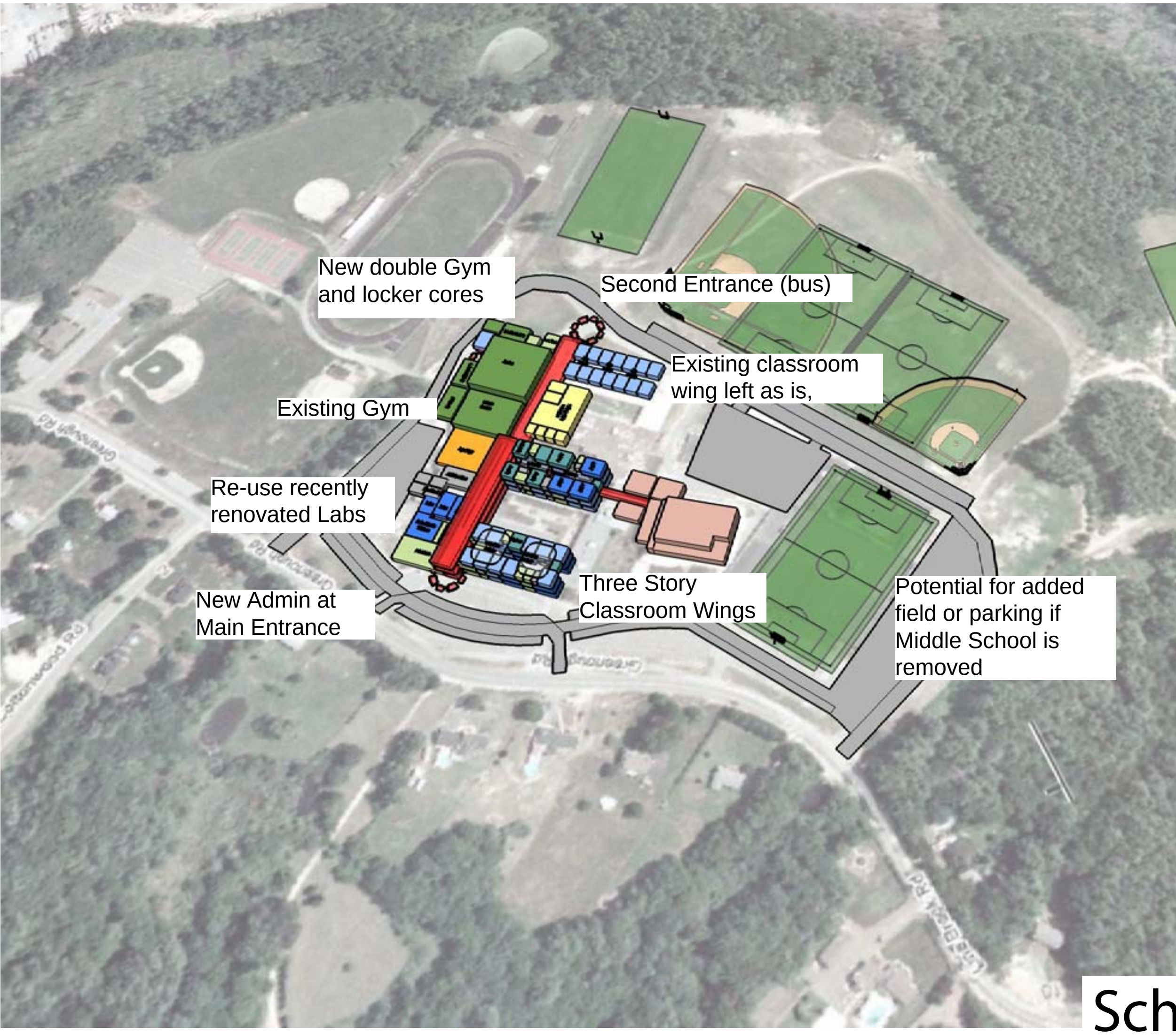
Scheme C First Floor

Conceptual Diagrams



Scheme C Second Floor

Conceptual Diagrams



Scheme D Talking Points

-Reconstruction of HS Building into New High School. Replaces all education areas with 3 Story Classroom Wings. Renovates and re-uses Cafeteria, new labs, Gym, mechanical areas, and newest classroom wing.

-Pro: Creates all new education spaces suitable for 21st century education.
-Pro: re-uses many areas
-Pro: Connects High School to Performing Arts Center
-Pro: Reorganized building to "Main Street" Concept
-Pro: All departments have a face on "Main Street"
-Pro: Resolves all issues with existing building.
-Pro: Integrates Guidance and Special Education into education areas
-Con: Requires DOE permission given that will exceed 60% of new building cost.
-Note: Requires new middle school and second access to address site issues.

Scheme D Overall Site Plan

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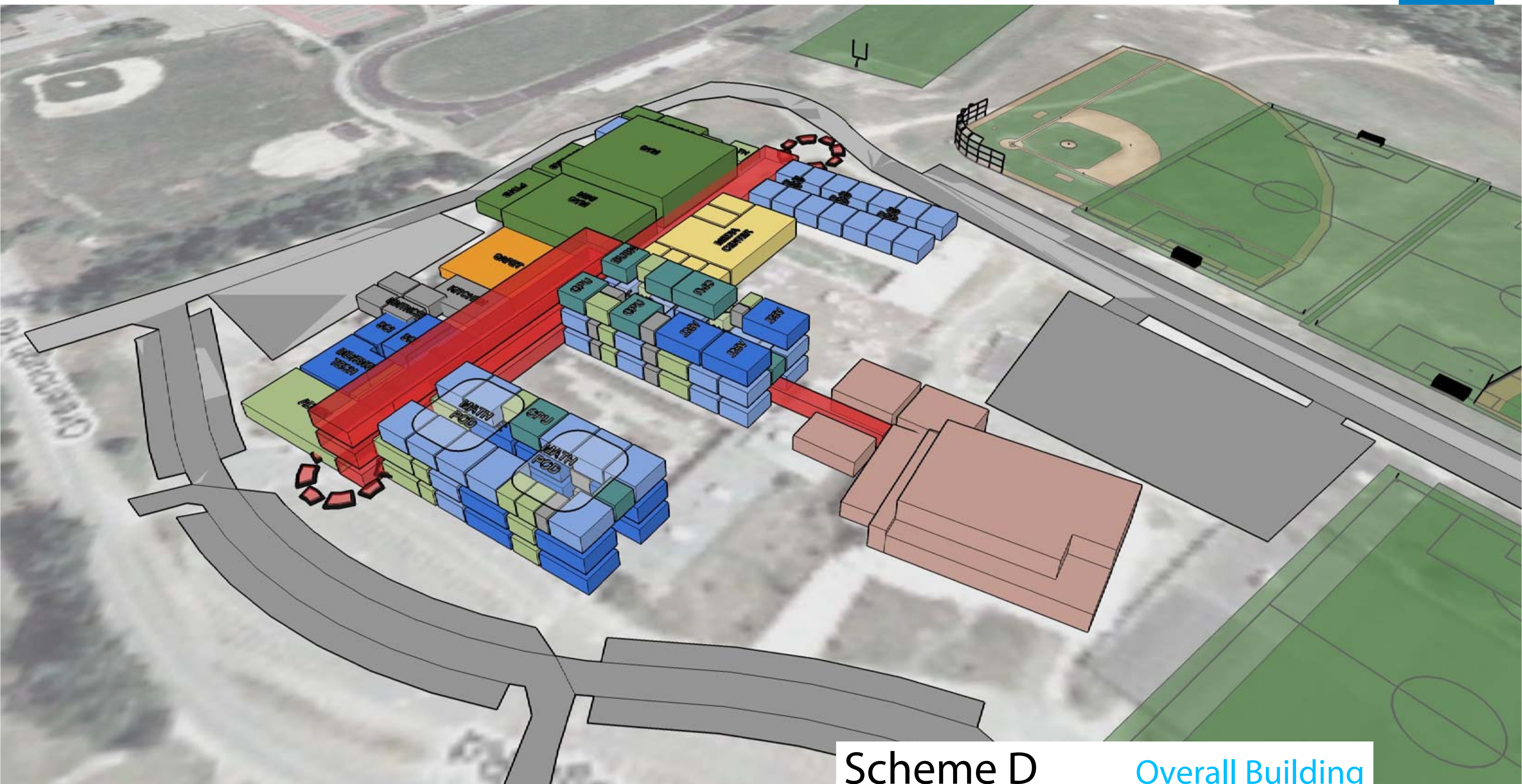
Conceptual Diagrams



Scheme D Overall Building

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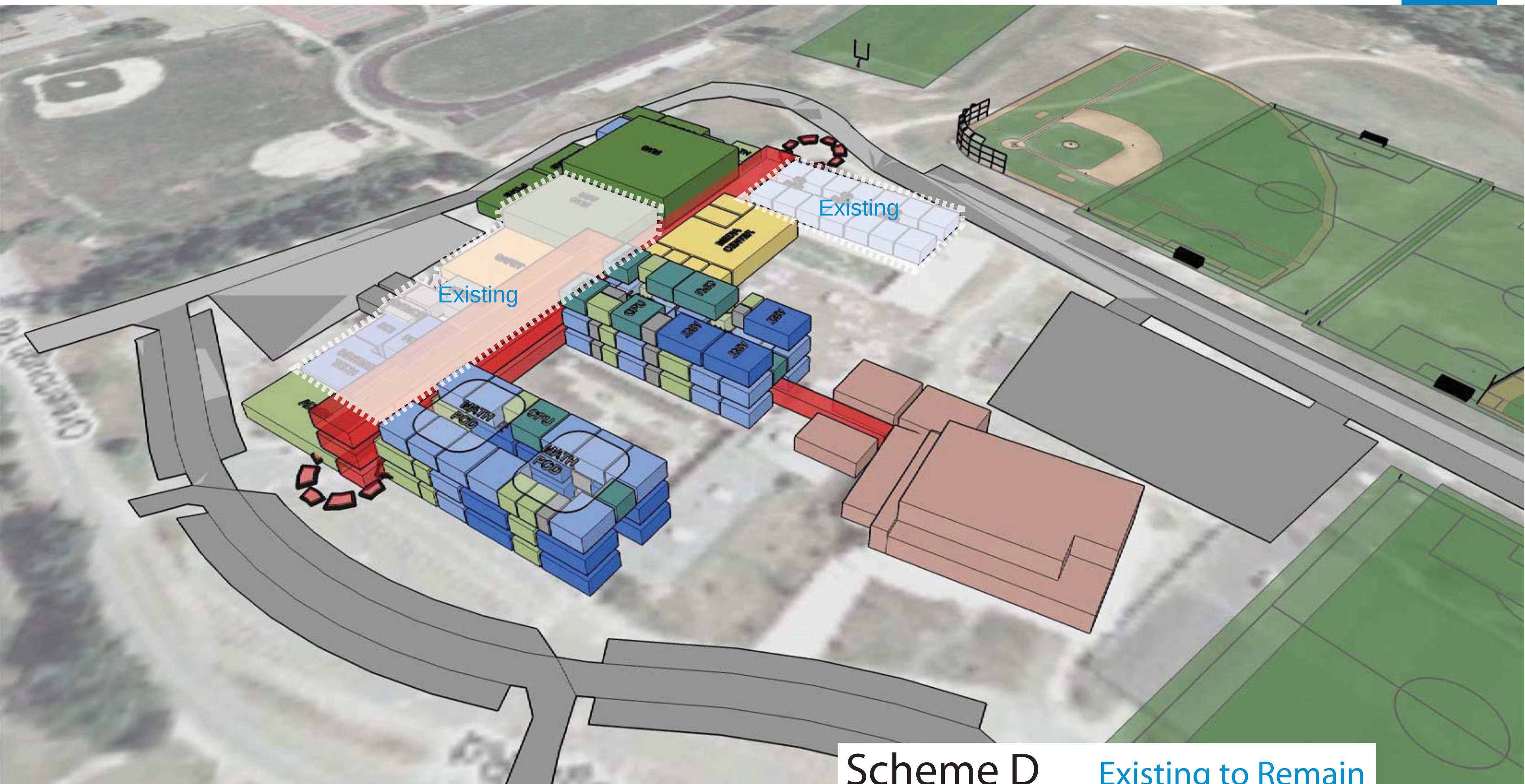

Scheme D Existing to Remain

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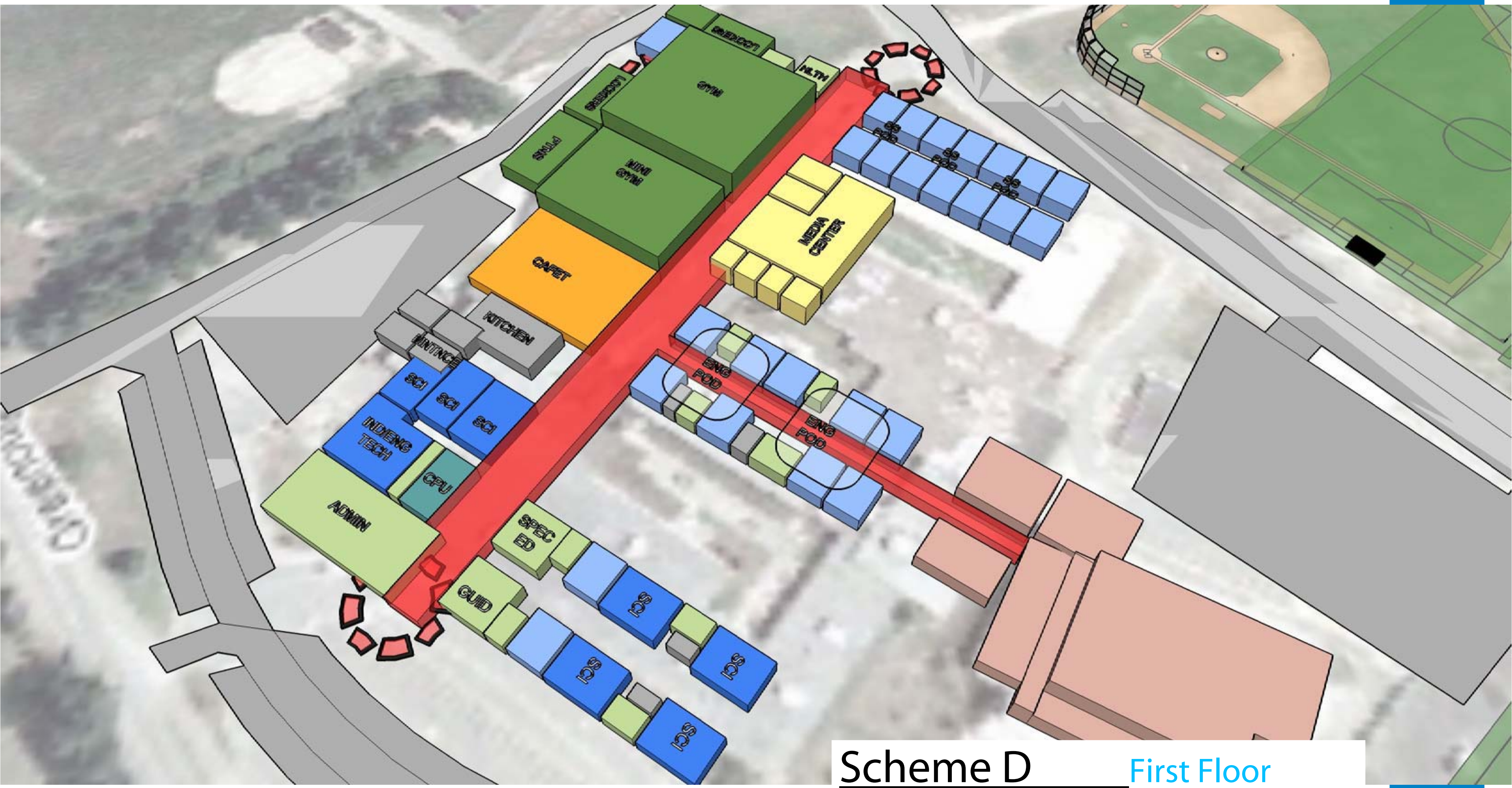

Scheme D First Floor

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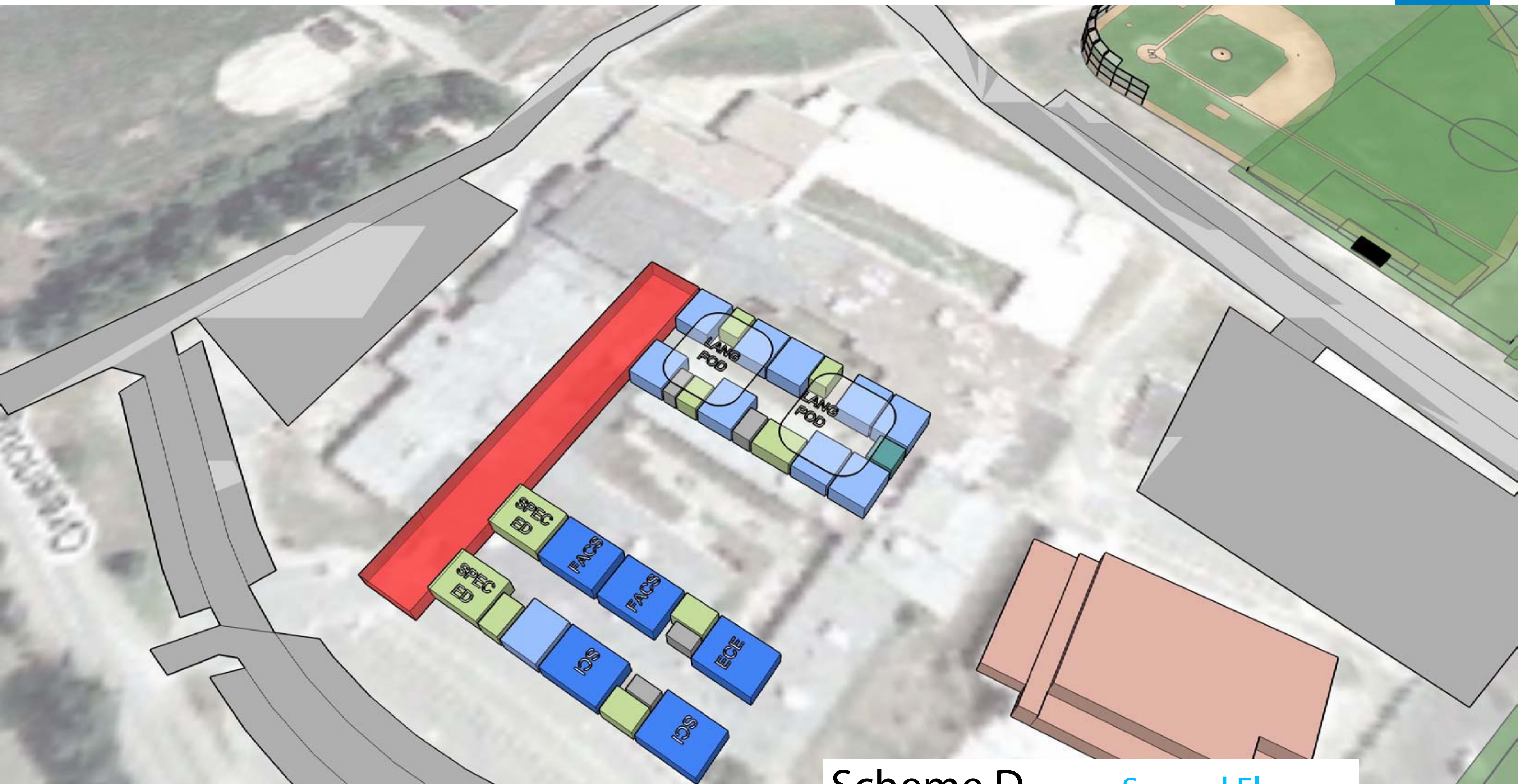

Scheme D Second Floor

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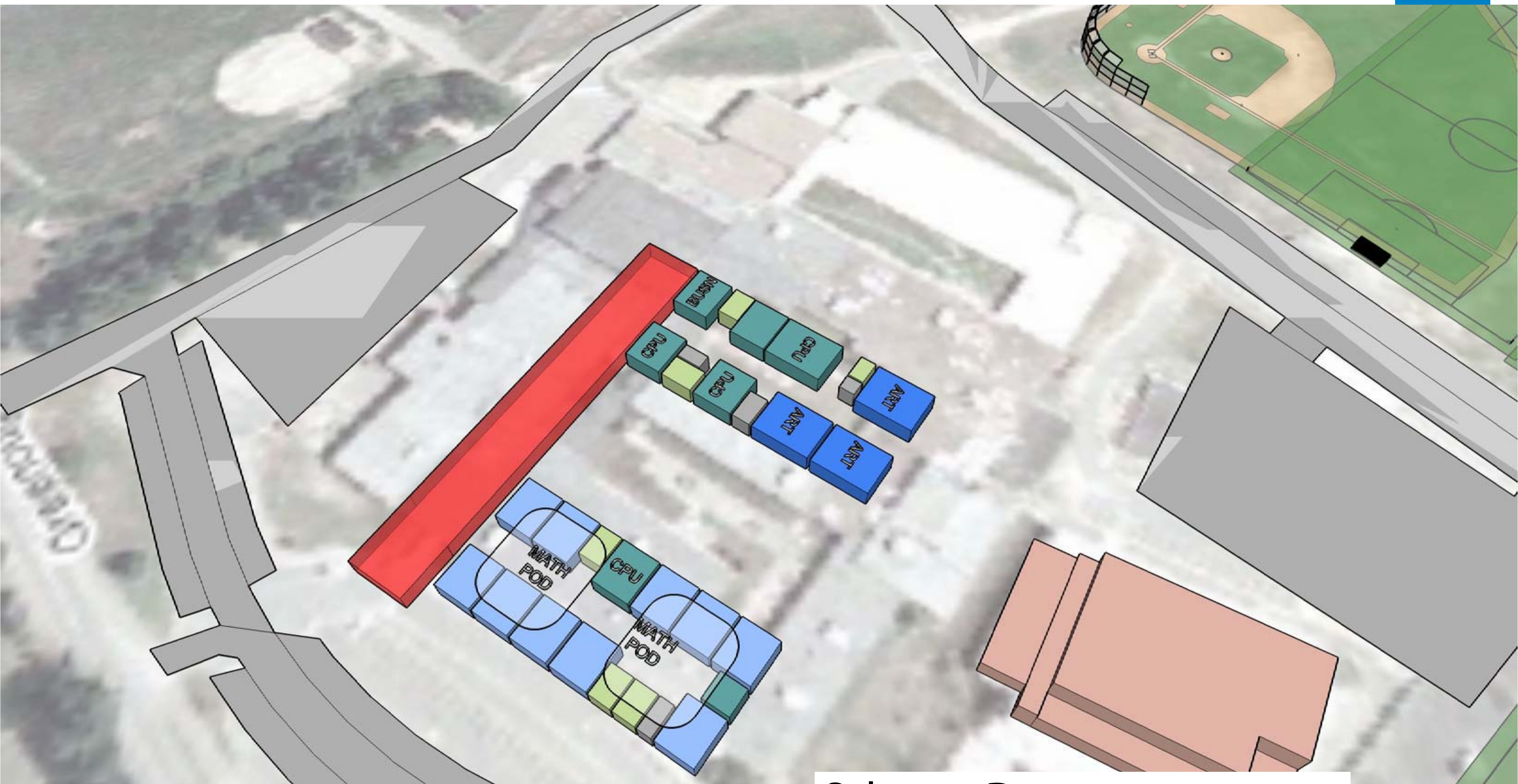

Scheme D Third Floor

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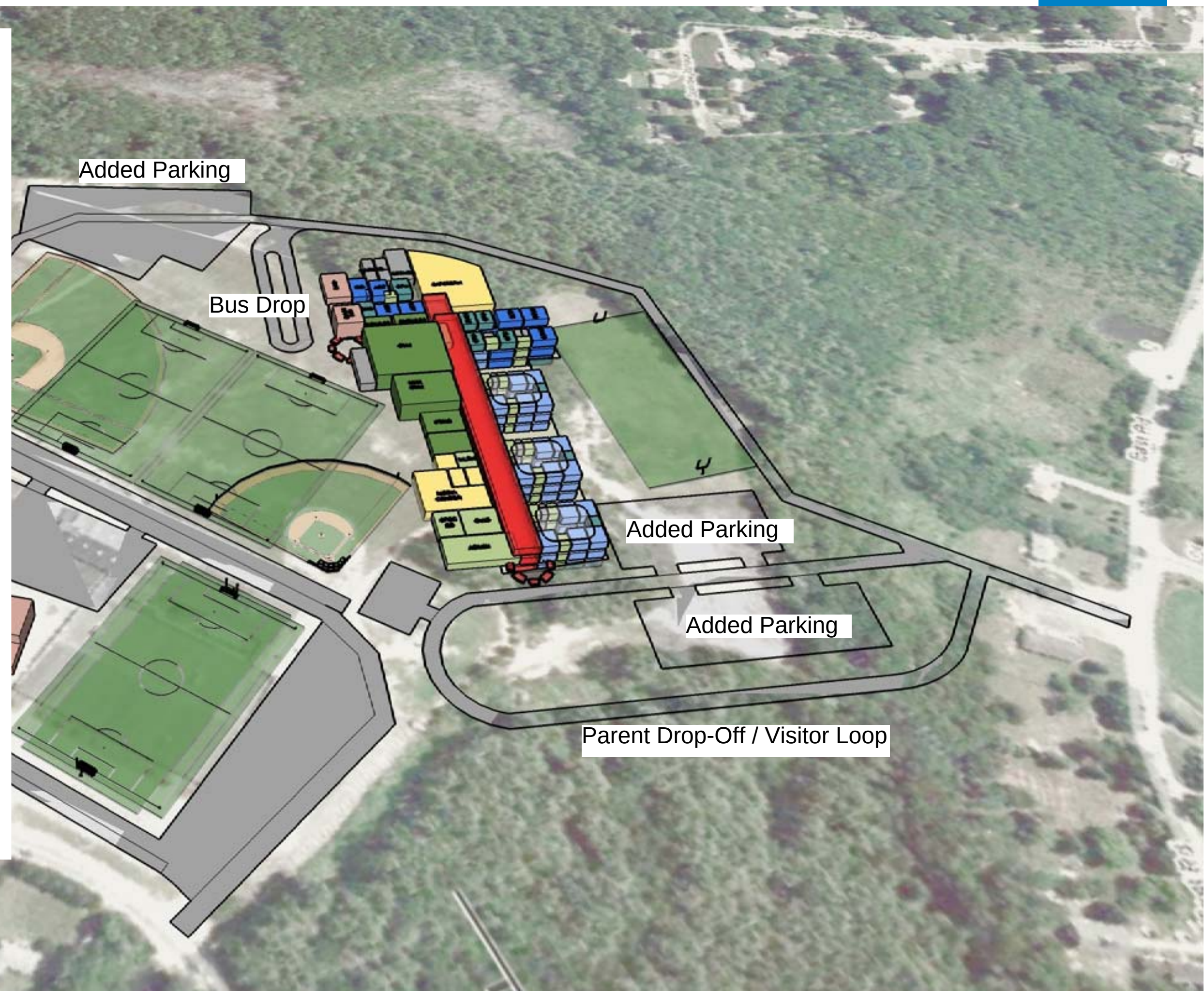
Conceptual Diagrams

Scheme E Talking Points

-New High School located at sloped area on site. Three stories, enter at 2nd floor, one floor up and one floor down.

-Pro: Access off East Road would improve congestion. (If access not obtained from East Road, scheme is still viable, however, site issues will remain).
-Pro: Uses property not suitable for field or parking development, and takes advantage of sloping site.
-Pro: Efficient, intuitive design.
-Pro: All departments have a face on "Main Street"
-Pro: All areas having an outside wall allows for future growth of any given area (core or classroom areas).
-Pro: Flexible pod design allows areas to either be discipline focused or set up as academies.
-Pro: Integrates Guidance and Special Education into education areas
-Pro: Faces classrooms south with good light and views
-Con: Separates High School from Performing Arts Center
-Note: Requires either new Middle School or renovation of HS Building into Middle School



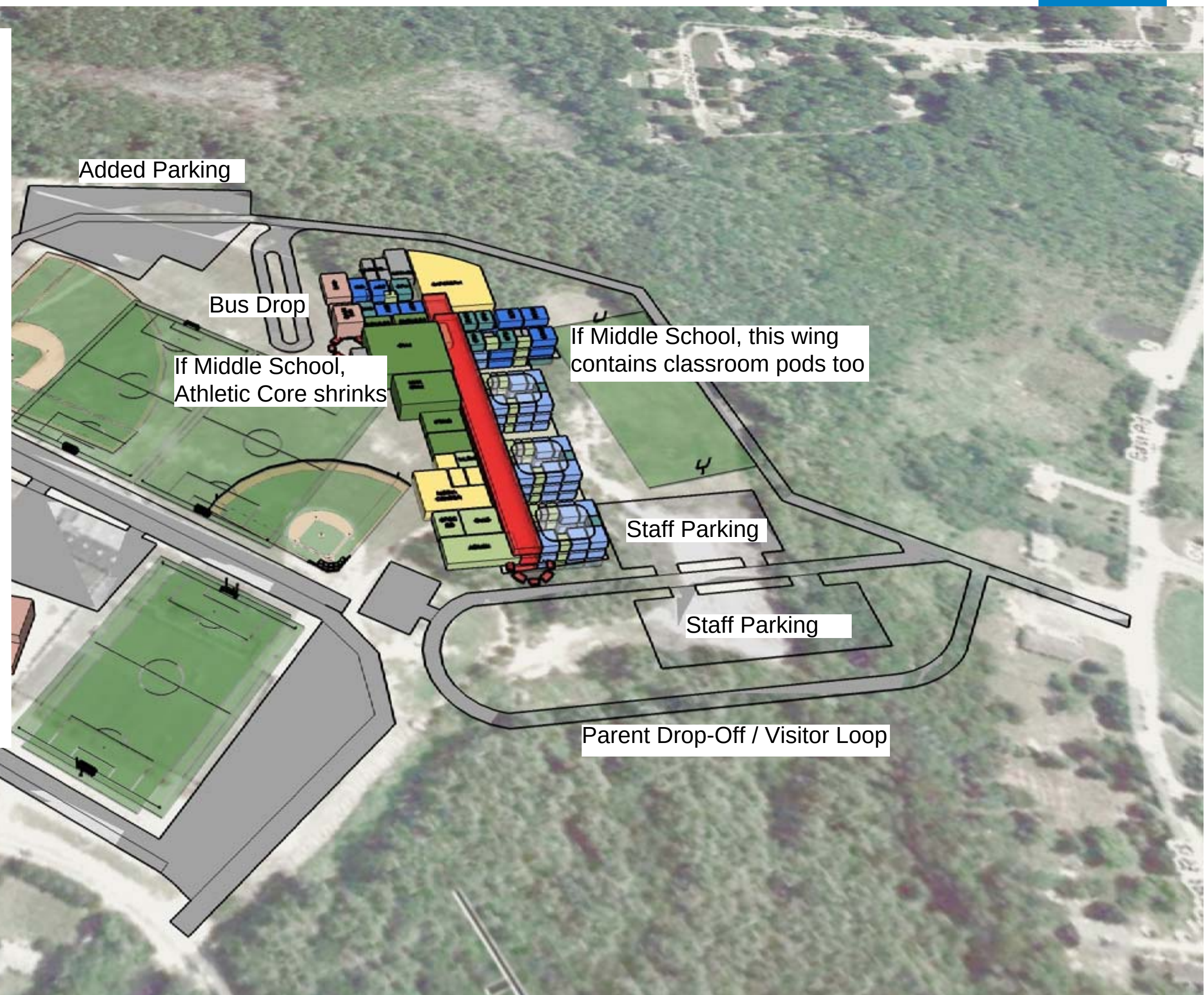
Scheme E Overall Site Plan

Conceptual Diagrams

Scheme E2 Talking Points

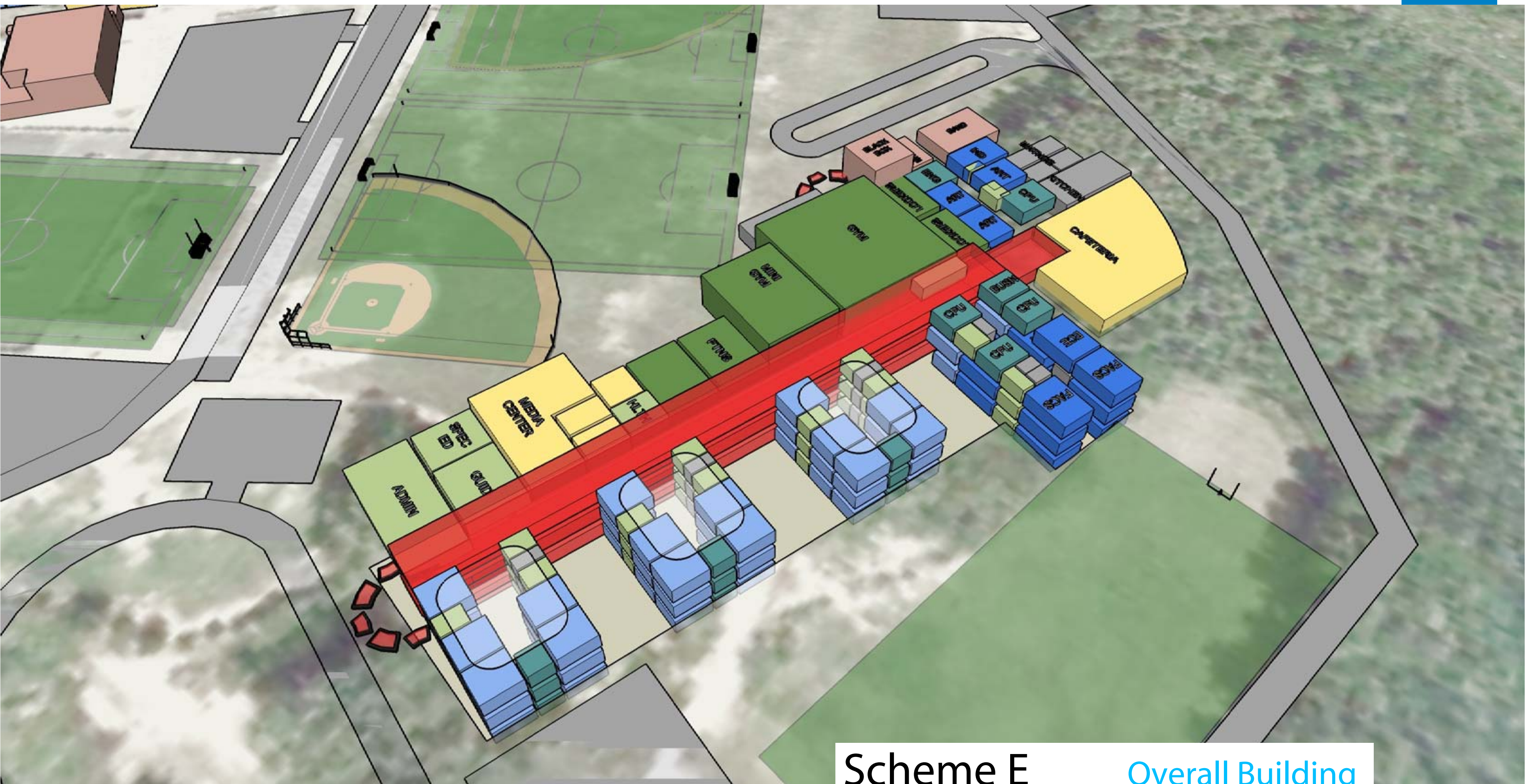
-New Middle School located at sloped area on site. Three stories, enter at 2nd floor, one floor up and one floor down.

-Pro: Access off East Road would improve congestion. (If access not obtained from East Road, scheme is still viable, however, site issues will remain).
-Pro: Uses property not suitable for field or parking development, and takes advantage of sloping site.
-Pro: Efficient, intuitive design.
-Pro: Layout allows for no through-travel in Pods
-Pro: Separation of Grades by floor further allows for student Pods to feel isolated, enforcing the "schools within schools" concept.
-Pro: Faces classrooms south with good light and views
-Pro: Allows HS to remain with PAC
-Note: Requires renovation of HS Building.



Scheme E Overall Site Plan

Conceptual Diagrams



Scheme E Overall Building

Conceptual Diagrams

Scheme E Main Floor

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Conceptual Diagrams

Scheme E Lower Floor

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Conceptual Diagrams

Scheme E Upper Floor

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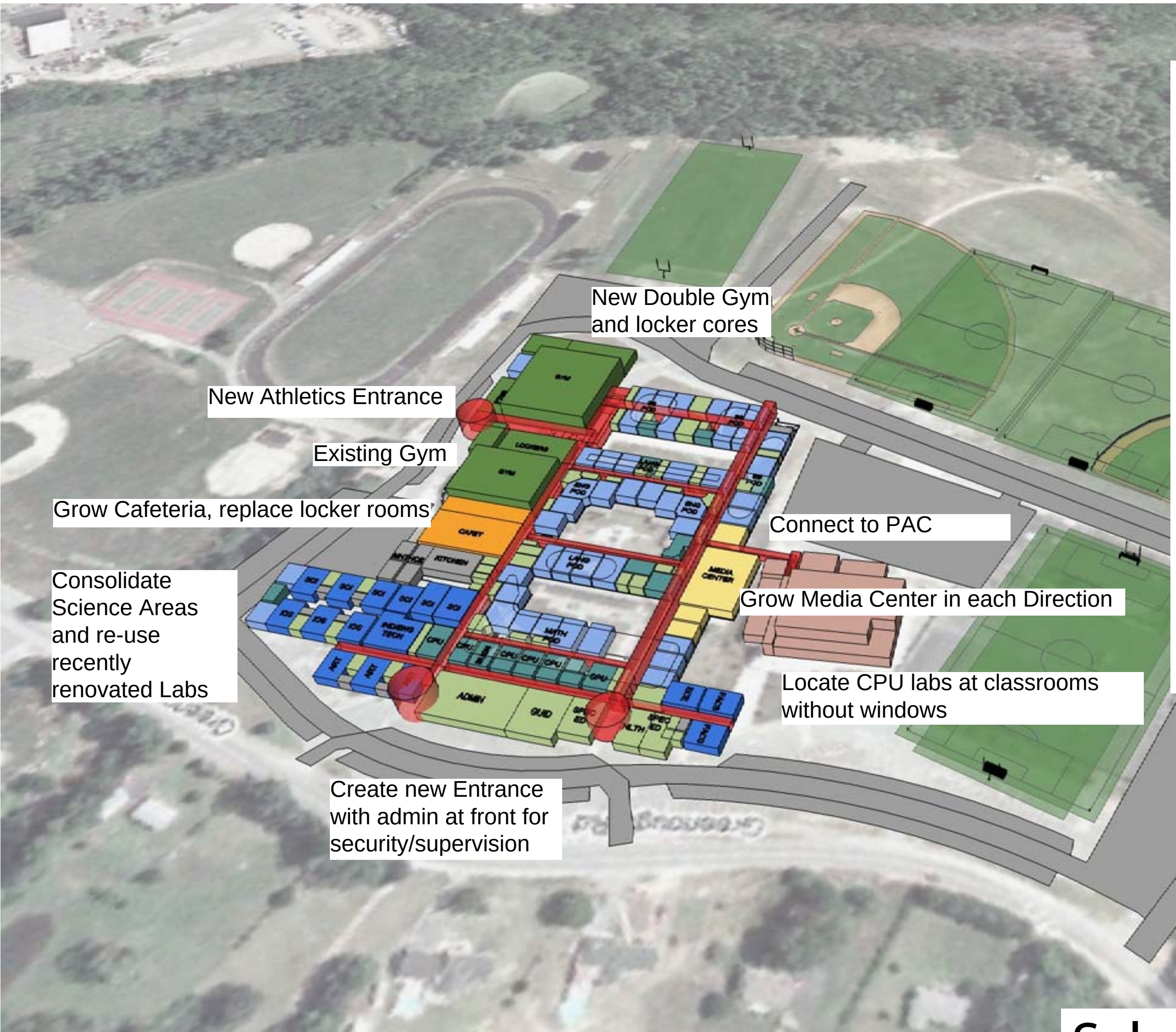
Conceptual Diagrams



Scheme F Talking Points

-High School renovated in place to meet needs of population. Middle School relocated (on-site or off) enables potential added ball-field and/or parking.

-Note: Renovations to include exterior walls of building complete for Energy Upgrades and address of all code related issues.
-Pro: Re-uses nearly the entire HS Building
-Con: Does not create "Pod" type focus areas well
-Con: Will not solve supervision issues or flow issues with current building
-Con: Does not integrate Special Education and Guidance throughout the education areas well.
-Note: Must work with DOE to obtain permission if exceeds 60% cost of new building

Scheme F Overall Site Plan

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Conceptual Diagrams

Scheme F Overall Building

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Conceptual Diagrams

Scheme F
Floor 1

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Conceptual Diagrams

Scheme F

Existing to remain

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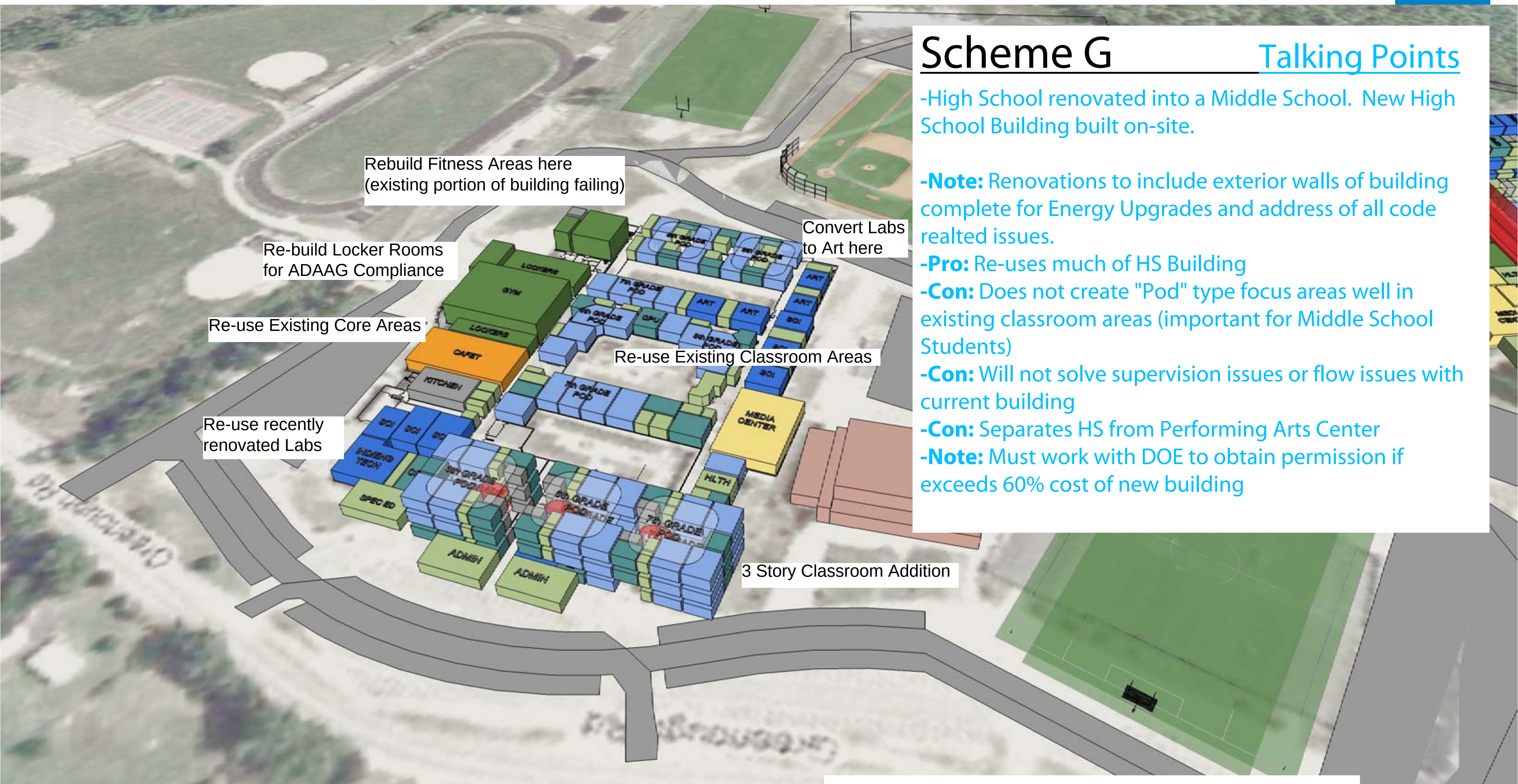
Conceptual Diagrams



Scheme G Talking Points

-High School renovated into a Middle School. New High School Building built on-site.

-Note: Renovations to include exterior walls of building complete for Energy Upgrades and address of all code realted issues.
-Pro: Re-uses much of HS Building
-Con: Does not create "Pod" type focus areas well in existing classroom areas (important for Middle School Students)
-Con: Will not solve supervision issues or flow issues with current building
-Con: Separates HS from Performing Arts Center
-Note: Must work with DOE to obtain permission if exceeds 60% cost of new building

Scheme G Overall Site Plan

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Conceptual Diagrams

Scheme G Overall Building

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Conceptual Diagrams

Scheme G Existing to Remain

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Conceptual Diagrams

Scheme G Floor 1

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Conceptual Diagrams

Scheme G

Floor 2

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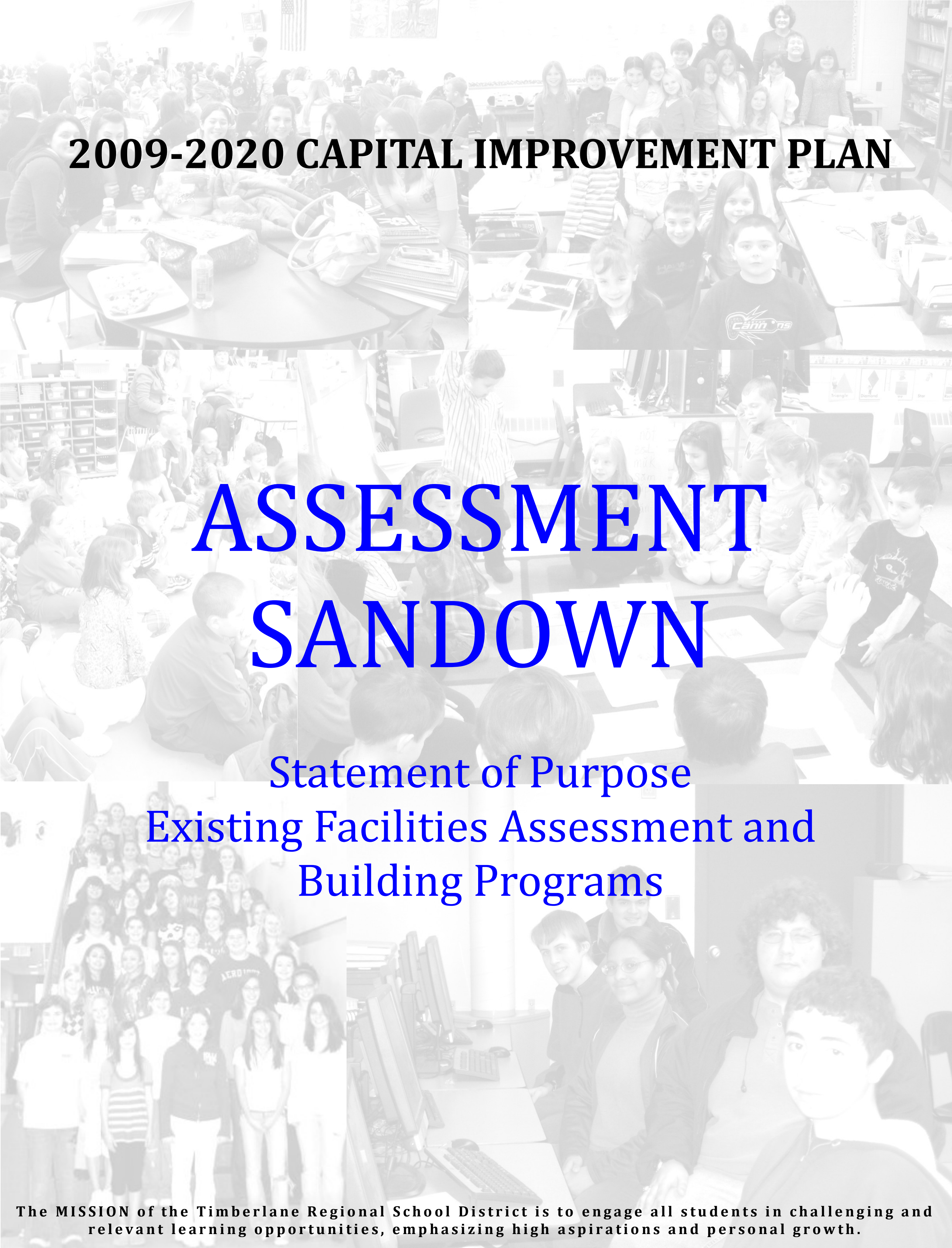
Conceptual Diagrams

Scheme G

Floor 3



2009-2020 CAPITAL IMPROVEMENT PLAN

ASSESSMENT SANDOWN

Statement of Purpose
Existing Facilities Assessment and Building Programs

The MISSION of the Timberlane Regional School District is to engage all students in challenging and relevant learning opportunities, emphasizing high aspirations and personal growth.

STATEMENT OF PURPOSE
SANDOWN NORTH AND CENTRAL CONSOLIDATION

The Timberlane Regional School District administration, along with Lavallee Brensinger Architects, submits this feasibility report relative to the potential for consolidation of the Sandown North and Central Schools.

The New England School Development Council (NESDEC) has conducted a detailed Enrollment and Demographic Analysis of the Timberlane Regional School District covering the next ten years. The analysis projects a decline in the District's student enrollment at the K-5 levels from 1916 students in 2007-2008, to 1587 students in 2017-2018. The Sandown projections reflect a potential decline from 385 in 2007-2008 to 361 in 2011-2012. This anticipated decline in enrollment represents a reversal of a 10-year pattern of growing enrollment and increasing facilities needs for space. *What are the short-term, medium-term, and long-term implications and opportunities associated with enrollment decline in the Sandown school community?*

Given these declining enrollment projections, given the age and design deficits of Sandown Central, and given the increased expense and decreased efficiency of maintaining two buildings:

- *Is it possible, feasible and desirable to enlarge the Sandown North facility thereby closing, selling, or repurposing the Sandown Central facility?*

- *What would be the potential operational savings? What would it cost to enlarge and modify Sandown North?*

- *What would be the educational, social, and emotional impact on students?*

- *Could some of the current deficits with the Sandown North facility and site be addressed during renovation/addition?*

- *What would be the timeframe and impact on building use and instruction during a renovation/addition project?*

The attached report asks these questions and seeks to inform the District administration, School Board, Budget Committee and the public of the opportunities and challenges associated with school consolidation in Sandown.

❖ *What would be the educational, social, and emotional impact on students should the two schools consolidate?*

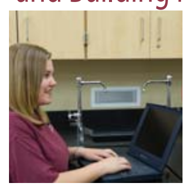
EDUCATIONAL IMPACT

- There would be a benefit to the coordination of curriculum and instructional strategies.
- Offer a more consistent delivery of curriculum from grade to grade.
- It would improve the coordination of resources; especially for remedial, enrichment, and the unified arts areas.
- It would allow for clear mission, goals, and leadership team to support student learning.
- Academic structures would be in place to support programs such as scheduling of literacy block, remedial/enrichment time, and math blocks.

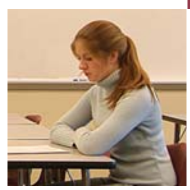
SOCIAL AND EMOTIONAL IMPACTS

- Students would receive the benefit of two more years of the well established PBIS system of behavior supports and a positive learning environment.
- Students would receive the benefit of two more years with staff who know the students and their families well.
- It would meet the safety and security needs of children.
- It would reduce the number of transitions within a two year period with just one transition to the middle school.
- It would allow for pre-teens, who are developmentally ready, to engage in more leadership roles as well as provide leadership modeling for younger students.

Existing Facilities Assessment and Building Programming



TIMBERLANE REGIONAL
SCHOOL DISTRICT (SAU 55)



Sandown North and Sandown Central
Elementary Schools
Assessment and Conceptual Planning

December 4, 2008

Lavallee Brensinger
ARCHITECTS

Your mission inspires us. Our creativity and knowledge empower you. **Together we achieve excellence.**

Lavallee Brensinger Architects 155 Dow Street, Suite 400 Manchester NH 03101 tel 603-622-5450 fax 603-622-7908 web LBPA.com

Timberlane Sandown North School December 4, 2008
Existing Condition Assessments

Lavallee Brensinger Architects offers the following assessment of the existing Timberlane Sandown North School and Site Facilities. This report is based on meetings with the School Administrators and the Facilities Director, site visits, including a building tour of the facilities by Lavallee Brensinger Architects, and a review of the most recent floor plans. The facility has been reviewed, and recommendations based on, current design practices, current code compliance, and current Educational guidelines as published by the State of New Hampshire Department of Education.

Site Assessment:

The Sandown North School is located at 23 Stagecoach Road in Sandown NH, at the end of a dedicated drive. Secondary access to the facility is located on the back side via a small maintained access off from Rangeway Avenue, a nearby residential street. The area surrounding the school can be characterized as rural residential and is well suited for a safe elementary school site. Overall the site is 42 acres, including some scattered wetlands, and is slightly sloped and partially wooded. At the front of the school, a short rise gives way to an upper terrace. The upper terrace is a fairly flat section of gravel based clearing with potential for parking or small athletic field development. There are currently no athletic fields on site. Based on current school design standards, some space for outdoor athletics should be incorporated into site planning for implementation during a renovation of this building, or at least planned for future implementation. Ideally, such green space would be accessible during the school day so that it could be incorporated into the physical education curriculum.

All vehicular traffic approaches via Stagecoach Road, until it encounters a loop road around the school building itself. Parents drop off and pick up at the rear of the building by taking a right at the intersection, while busses stay left and drop off/pick up students at the school's main entrance. Visitor parking is located at the main entrance, while faculty parking is located past the main entrance. Sandown Faculty and School District staff note a shortage oF parking for events, (particularly open houses for the school) which must be addressed. There are approximately 21 visitor and 53 staff parking spaces currently onsite, serving a current population of 340 students. Should Sandown Central's population be consolidated here, the student capacity would rise to 500 students and approximately 50-60 staff members, therefore requiring additional parking. The number of additional spaces required must be set by the school district, as parking provided for elementary schools varies greatly (given that so many of the occupants are not eligible to drive). While the Department of Education requires only enough parking to accommodate school employees, many Districts base the need for parking on specialty events such as open houses and athletic events such as basketball.

A playground is located behind the school outside the loop road. The playground equipment is recent and in good condition. The location of the playground presents a potentially dangerous intersection of students and cars should the school wish to allow use of the playground during school opening and closing. This intersection also occurs for any deliveries made to the school during student recess. Two gates are currently used to avoid any interaction of students with traffic. Any site planning efforts should investigate possible solutions to allow the school extended use of the playground.

Building Condition:

The Sandown North Elementary School is a 47,500 gross square feet (not including mechanical penthouse) single story wood framed building completed in 2000 which remains in very good condition. The exterior envelope is a mixture of siding materials over wood stud and cavity insulation, with CMU back up in walls at the gymnasium and related areas. Interior walls are gypsum partitions and appear to be in good condition. Classrooms finishes are vinyl composite tile (VCT) floors with suspended acoustic ceiling tile (ACT) ceilings, and also appear in good condition. Mechanical and electrical systems appear well maintained, and could be supplemented with additional systems should an addition to the building be provided.

Building Codes:

While the building is not fully protected with an automatic sprinkler system, it does appear to meet current Fire Codes. While the department of education encourages all schools to use sprinkler systems, they are not required as long as the building does not exceed maximum sizes prescribed by the current fire code. This building falls below the maximum allowable building areas through use of masonry fire walls, separating the facility into five buildings (independent fire areas). Any additions to the building will likely need to be separated as yet another fire area, depending on which fire area it connects to, via masonry or other firewall (similar to existing design. Even if not required by current codes, any capital improvement projects to this school should consider protecting the entire building throughout with an automatic sprinkler system for safety reasons (as well as for protection of the facility itself).

Today's schools strive to not only meet the current energy code, but to exceed it. This building with the current wall system does meet the current energy code by utilizing R-19 insulation within the stud cavity; however, it should be noted that the overall R-value of this system is calculated at approximately R-16.26 when calculating for reduction of R value at stud locations. Any additional space should exceed the current construction in terms of energy conservation and exterior envelope design.

Compliance with the Americans with Disabilities Act is a requirement of any new, or renovated educational facility. In review of the drawings and a walk-through of the facility, no violations were readily noticeable.

Functional Requirements:

A fundamental question in the assessment of any facility is whether or not it supports its intended use.

This building is a standard layout elementary school design, typical of elementary schools since the 1970s. The overall plan consists of two classroom wings containing a series of 870 square foot classrooms, each with 5 computer stations and approximately 690 square feet of usable floor area for general classroom activities. These classrooms and other miscellaneous teaching spaces are slightly undersized compared to current NH Department of Education Standards, but are currently meeting the needs of the classes housed. We would suggest that the Kindergarten programs be relocated into larger classrooms given the space needs for this particular age group (Recommended 1000 sf min). Select additional classrooms should also incorporate operable walls so that team teaching strategies could be implemented, particularly at the 4/5 level. While the overall layout of the building is not particularly innovative, it does suit the needs of a modern elementary school. Given that the grades housed would expand from K-3rd grade to K-5th grade under a consolidation scenario, further organization of the building should consider separation of students by grade level to ensure the building remains safe and friendly for all students.

The "core areas", including the media center, the cafeteria, the gymnasium, and the administration areas, are located nicely at the main entrance to the building. The current entrance design offers the administration the ability to secure the building for a safe elementary school environment. The Media Center, the Administration, and the Athletic Areas are slightly undersized for a current student population of approximately 340 students, and therefore should be upgraded when the capacity of the building rises to 500 students.

Support spaces for faculty are adequate, but could be upgraded. There is one designated team meeting space (shared as the large conference room by the entire school), but additional areas should be added as the student population grows. Meeting areas for Special Education Services or for teacher team meetings should be integrated into the classroom wings. Small group Instructional spaces would also benefit the faculty's ability to implement one-on-one or small group teaching as required. Like many schools, Sandown North lacks sufficient storage space (both in the classroom wings as well as in the athletic area, and also for the building overall). Additional storage space should be considered as part of any building additions to help alleviate the current shortage.

Sandown Central School:

The Sandown Central Elementary School was toured briefly and the documents reviewed as well. It should be noted that this facility is not in nearly as good condition as the Sandown North School. The 52,500 square foot building is located on a small 5.25 acre site in downtown Sandown, adjacent to route 121A. The site does contain an athletic field and a playground, but is very limited in terms of expansion. The building itself is a collection of additions of various forms and materials, many of which are at the end of their life cycle. While aesthetics is a very subjective topic, this building cannot be considered aesthetically pleasing by any measure.

The overall layout of the building is complex and not intuitive nor efficient. The main entrance is flanked by administration areas, providing a security checkpoint for the building, as well as the Media Center. The main entrance leads down the core building areas into a collection of classroom and special education spaces. The Cafeteria and Gymnasium share one large space, a design indicative of the 1960s and earlier elementary school philosophies. A second entrance is located at the rear of the building, allowing for students to access the play area. Similar to the North School, the play area here intersects a vehicular access, therefore posing a safety concern for school staff to address on a daily basis.

While it appears that the district has upgraded and repaired this facility to the best of their ability, we feel that this building will remain inefficient in terms of space utilization. Overall, the facility serves only 160 students with its 52,500 square foot footprint, totaling 328 square feet per student (Note that the NH department of Education sets the maximum square footage of new elementary schools to 144 square feet per student (120 sf when serving 250 students or more)). Renovation of this building to become more efficient does not appear feasible at this time, given such a large renovation would trigger current code compliance. While existing buildings are generally "grandfathered" by many codes, and therefore not required to be constantly altered or improved to maintain full code compliance, any significant alteration of the facility would trigger requirements for updating systems to meet current codes. Per the NH Department of Education's Minimum Standards for Public Schools (Ed 321.27) if a renovation exceeds 60% of the cost for new construction, "*The scope of the renovation project shall provide that all building systems shall be upgraded to the most current codes and standards and that the building shall be fully accessible to individuals with disabilities.*"

Summary:

Based upon our tour of the facility and a preliminary review of the information available to us, our professional assessment of this building is that the Sandown North Elementary School does meet the current requirements for it's student population (although some improvements mentioned above would be beneficial) and that an addition to the building in an attempt to consolidate this building with the Sandown Central School is possible.

We at Lavallee Brensinger have always been proponents of locating school facilities in town core areas, and realize that school buildings are an asset to any community they are located within. Neighborhood centered schools benefit communities as a whole and promote healthier town environments by being located within walking distance to so many residences. That being noted, we feel that consolidation of the two schools would benefit the district as a whole by bringing the programs under one roof and preventing the district from spending additional funds to operate a very inefficient Sandown Central School. As the District and the community consider the consolidation of these buildings, careful thought should be given as to what happens to the existing Sandown Central Facility. This property can be considered a valuable asset to the community and might lend itself towards an alternative use.

Should the community not feel that consolidation is in their best interests, and choose to maintain the a school at the Sandown Central site, careful thought should be given to long term planning for this facility. Based on our preliminary review and issues listed earlier, a full reconstruction of the building and vehicular areas is likely the best long term plan to maintain this facility as an elementary school.

Sincerely,

Lance Whitehead, Project Manager
Lavallee/Brensinger Architects

Fred Urtz, AIA, President
Lavallee/Brensinger Architects

Room Type	Total Students	Max Persons/ Area	Min NSF/ Person	Min NSF/ Area	Adjusted	Number Req'd	Total Area	Comments	Existing Number	Existing NSF/Area	Total Existing	Difference New/Exist	
EDUCATIONAL SPACE													
Pre School (Future)													
Classrooms	40 (1/2 day)	20	32	640	1,100	1	1,100		0	0	0	1,100	
Restroom		1			60	1	60		0	0	0	60	
Storage					80	2	160		0	0	0	160	
Copy Center / Work room					100	1	0	Shared with Other Grades	0	0	0	0	
							1,320				0	1,320	
Kindergarten													
Classrooms	80 (1/2 day)	20	32	640	1,100	2	2,200		2	870	1740	460	
Shared Restroom		1			60	1	60		1	60	60	0	
Storage					80	2	160		0	0	0	160	
Copy Center / Work room					100	1	100		0	0	0	100	
							2,520				1,800	720	
1st Grade													
Classrooms	96	20	32	640	870	4	3,480	Adjusted to match existing room sizes	4	870	3480	0	
Shared Restroom		1			60	2	120		2	60	120	0	
Small Group Classroom / Coordination		12	32	384	450	1	450	Shared with Other Grades	0	0	0	450	
Special Education / Meeting Area		4	32	128	300	1	300		1	233	233	67	One shared Existng
Storage					80	2	160		0	0	0	160	
Copy Center / Work room					100	1	100	Shared with Other Grades	0	0	0	100	
							4,610				3,833	777	
2nd Grade													
Classrooms	96	20	32	640	870	4	3,480	Adjusted to match existing room sizes	4	870	3480	0	
Shared Restroom		1			60	2	120		2	60	120	0	
Small Group Classroom / Coordination		12	32	384	450	1	0	Shared with Other Grades	0	0	0	0	
Special Education / Meeting Area		4	32	128	300	1	300		0	0	0	300	
Storage					80	2	160		0	0	0	160	
Copy Center / Work room					100	1	0	Shared with Other Grades	0	0	0	0	
							4,060				3,600	460	
3rd Grade													
Classrooms	96	22	32	704	870	4	3,480	Adjusted to match existing room sizes	4	870	3480	0	
Shared Restroom		1			60	2	120		2	60	120	0	
Small Group Classroom / Coordination		12	32	384	450	1	450	Shared with Other Grades	0	0	0	450	
Special Education / Meeting Area		4	32	128	300	1	300		0	0	0	300	
Storage					80	2	160		0	0	0	160	
Copy Center / Work room					100	1	100	Shared with Other Grades	0	0	0	100	
							4,610				3,600	1,010	
4th Grade													
Classrooms	96	22	32	704	900	4	3,600	At least 1 Operable wall / paired CR	0	0	0	3,600	
Shared Restroom		1			60	2	120		0	0	0	120	
Small Group Classroom / Coordination		12	32	384	450	1	0	Shared with Other Grades	0	0	0	0	
Special Education / Meeting Area		4	32	128	300	1	300		0	0	0	300	
Storage					80	2	160		0	0	0	160	
Copy Center / Work room					100	1	0	Shared with Other Grades	0	0	0	0	
							4,180				0	4,180	

Room Type	Total Students	Max Persons/ Area	Min NSF/ Person	Min NSF/ Area	Adjusted	Number Req'd	Total Area	Comments	Existing Number	Existing NSF/Area	Total Existing	Difference New/Exist	
5th Grade													
Classrooms	96	24	32	768	900	4	3,600	At least 1 Operable wall / paired CR	0	0	0	3,600	
Shared Restroom		1			60	2	120		0	0	0	120	
Small Group Classroom / Coordination		12	32	384	450	1	450	Shared with Other Grades	0	0	0	450	
Special Education / Meeting Area		4	32	128	300	1	300		0	0	0	300	
Storage					80	2	160		0	0	0	160	
Copy Center / Work room					100	1	100	Shared with Other Grades	0	0	0	100	
							4,730				0	4,730	
Art	Once per week at 1-2-3, Twice per week at 4-5 = 28 periods per week												
Art Studio Classroom		24	36	864	1,065	1	1,065	Adjusted to match existing room sizes	1	1065	1065	0	
Office/ Work / Storage Area		2			200	1	200		1	190	190	10	
Display Area					100	1	0	Integrate into Art room or Corrdior	0	0	0	0	
							1,265				1,255	10	
Specialty Programs													
Reading Room - Consulation area		3	36	108	170	1	0	Integrated into Classroom Areas (SGC)	0	0	0	0	
Reading Room - Teaching Area		12	36	432	450	1	0	Integrated into Classroom Areas (SGC)	1	870	870	-870	
Reading Room - Office Area		1	36	36	50	3	150		0	0	0	150	
Reading Room - Storage					100	1	100		0	0	0	100	
Math Coordinator Student Meeting Area		12	36	432	450	1	0	Integrated into Classroom Areas (SGC)	0	0	0	0	
Math Coordinator Office Area		12	36	432	450	1	450		0	0	0	450	
Health Education		24	32	768	870	1	870	Share Room w/ Technology Education	0	0	0	870	
Technology Education		24	32	768	870	1	0	Share Room w/ Health Education	0	0	0	0	
Computer Lab (WERP)		24	32	768	870	1	870	Adjusted to match existing room sizes	1	870	870	0	
							2,440				1,740	700	
Special Education													
Spec Ed Resource Room / Flex Area					870	1	870		0	0	0	870	SAU to Verify Need
Intensive Needs Area					900	1	900	Adjusted to match existing room sizes	1	900	900	0	
Occupational / Physical Therapy / Sensory					860	1	860	Adjusted to match existing room sizes	1	860	860	0	
							1,760				860	900	
Music / Perf. Arts	Once per week at 1-2-3, Twice per week at 4-5 = 28 periods per week												
Chorus / Band Room		48	25	1,200	1,200	1	1,200		1	930	930	270	
Performance Area		96	8	768	600	1	600	Stage Area Only - adjusted to match exst	1	600	600	0	
Large Practice Room		6			100	2	200		0	0	0	200	
Offices		3	75	225	225	1	225		0	0	0	225	
Storage Areas					300	1	300		3	40	120	180	
Instrument Storage					300	1	300		1	100	100	200	
							2,825				1,750	1,075	
				Total Education Spaces			33,000	Net Square Feet			18,438	14,562	

Room Type	Total Students	Max Persons/ Area	Min NSF/ Person	Min NSF/ Area	Adjusted	Number Req'd	Total Area	Comments	Existing Number	Existing NSF/Area	Total Existing	Difference New/Exist
CORE SPACE												
Administration												
Principal		1			165	1	165	Adjusted to match existing room sizes	1	165	165	0
Curriculum Coordinator / Asst Princ		1			130	1	130	Adjusted to match existing room sizes	1	130	130	0
Admin Support / Open Office		4	75	300	350	1	350	Adjusted to match existing room sizes	1	350	350	0
Reception/Waiting		6			150	1	150	Currently Integrated into Open Office	1	150	150	0
Work Room					400	1	400		0	0	0	400
Large Conference / Meeting		40			870	1	870	Adjusted to match existing room sizes	1	870	870	0
Small Conference / Meeting		6			180	1	180	Adjusted to match existing room sizes	1	180	180	0
Teachers Lounge					400	1	400	Adjusted to match existing room sizes	1	400	400	0
Paraprofessionals					200	1	200	Adjusted to match existing room sizes	1	200	200	0
File / Record Storage					300	1	300		0	0	0	300
							3,145				2445	700
Health Office												
Nurse Office		1			150	1	150		0	0	0	150
Entry / Waiting					200	1	200		0	0	0	200
Work Area		1			200	1	200		0	0	0	200
Sick / Treatment Area		1			150	1	150		0	0	0	150
Shared Treatment Area		2	75	150	150	2	300		1	382	382	-82
Storage					75	1	75		1	75	75	0
							1,075				457	618
Guidance												
Head Guidance Counselor		1			150	1	150	Adjusted to match existing room sizes	1	150	150	0
Psychologist		1			150	1	150	Adjusted to match existing room sizes	1	150	150	0
Guidance Open Office/ Work Area		1			150	1	150	Adjusted to match existing room sizes	1	150	150	0
Guidance Waiting		4			100	1	0	Shared w/ Main Office	0	0	0	0
Small Conference / Meeting		6			250	1	0	Shared w/ Main Office	0	0	0	0
File / Record Storage					100	1	100		0	0	0	100
							550				450	100
Special Education Offices												
Special Education Offices		1			160	2	320	Adjusted to match existing room sizes	2	160	320	0
Open Office / Work Room		2	75	150	557	1	557	Adjusted to match existing room sizes	1	557	557	0
Testing Room					110	1	110		1	110	110	0
Speech					200	1	200		1	200	200	0
File / Record Storage					100	1	100		0	0	0	100
Small Conference / Meeting		6	40	240	240	1	0	Shared with Main Admin	0	0	0	0
							1,287				1187	100
Media Center												
Library / Stacks		24	50	1,200	1,000	1	1,000		1	700	700	300
Reading Areas		24	50	1,200	1,000	1	1,000	Integrated into stack areas	1	664	664	336
Circulation					100	1	100		1	100	100	0
Librarian Office					100	1	100		0	0	0	100
CPU Lab		16	32	512	510	1	510	Shared CPU Labs w/ Access to outside	1	510	510	0
Distance Learning Center		16	32	512	510	1	510	Can be relocated - stays w/ CPU Lab	1	540	540	-30
Library Storage					200	1	200		1	160	160	40
							3,420				2674	746

Room Type	Total Students	Max Persons/ Area	Min NSF/ Person	Min NSF/ Area	Adjusted	Number Req'd	Total Area	Comments	Existing Number	Existing NSF/Area	Total Existing	Difference New/Exist	
Health & Physical Education													
Main Gym		24	110	2,640	4,635	1	4,635	Existing Currently Non-Dividable	1	4635	4635	0	Add dividing curtain
Fitness / Multi-purpose Classroom		24	110	2,640	2,000	1	2,000	Aerobics, Health Classes, Firness testing	0	0	0	2,000	
Outdoor PE Space						1			0				
Girls Locker Room		24	25	300	600	1	180	Adjusted to match existing room sizes	1	180	180	0	
Boys Locker Room		24	25	300	600	1	180	Adjusted to match existing room sizes	1	180	180	0	
AD / PE Office					170	1	170	Adjusted to match existing room sizes	1	170	170	0	
Storage					900	1	900		1	156	156	744	
							8,065				5321	2744	
Cafeteria													
Dining Area		200	15	3,000	3,000	1	3,000	Based on 3 Lunch Periods (2 grades	1	1600	1600	1,400	
Serving Area					600	1	0	per period).	0	0	0	0	
Kitchen					1,100	1	1,100	Integrate Serving into Dining Entry as is	1	1100	1100	0	
Dry Storage					150	1	150		1	70	70	80	
Walk-In Freezer					80	1	80	Adjusted to match existing room sizes	1	80	80	0	
Walk-In Refrigerator					80	1	80	Adjusted to match existing room sizes	1	80	80	0	
Locker Area					80	1	80		0	0	0	80	
Toilet					50	1	50	Adjusted to match existing room sizes	1	50	50	0	
Loading Area					100	1	100		0	0	0	100	
Cafeteria Office		1			50	1	50	Adjusted to match existing room sizes	1	50	50	0	
							4,690				3030	1660	
Maintenance													
Custodial Closets					40	8	320	Distributed Throughout the School	4	40	160	160	
Building Storage					800	2	1,600	Shared By Entire Building	2	250	500	1,100	
							1,920				660	1260	
Tech Support													
Central Server Room					200	1	0	Located Upstairs	1	0	0	0	
Satellite Server Room					60	1	0	Located Upstairs	0	0	0	0	
IT Office					100	1	100	Adjacent to CPU lab	0	0	0	100	
							100				0	100	
				Total Core Spaces			24,252	Net Square Feet			16224	8028	

EXTERIOR SPACES

Room Type	Total Students	Max Persons/ Area	Min NSF/ Person	Min NSF/ Area	Adjusted	Number Req'd	Total Area	Comments	Existing Number	Existing NSF/Area	Total Existing	Difference New/Exist	
Fields / Events (shared with High School)													
Multi-Use Athletic Field (Ext PE)						1	1		0	0	0	1	
Site Features													
Bus Drop Off Spaces		8	600	4,800		1	0.11	Acres	6			2	spaces
Faculty Parking		60	300	18,000		1	0.41	Acres	53			7	spaces
Kindergarten Parent Drop Off		12					1.00	Acres	0			12	spaces
Parent Drop Off		16					1.00	Acres	16			0	spaces
Maintenance Parking		2	300	600		1	0.01	Acres	0			2	spaces
Visitor Parking		20	300	6,000		1	0.14	Acres	20			0	spaces
Event Parking		60	300	18,000		1	0.41	Acres	0			60	spaces
							2.54	Acres					

122 Total parking

Room Type	Total Students	Max Persons/ Area	Min NSF/ Person	Min NSF/ Area	Adjusted	Number Req'd	Total Area	Comments	Existing Number	Existing NSF/Area	Total Existing	Difference New/Exist

Program Summary

Building Program

Total Core Spaces	24,252	Net Square Feet			
Total Education Spaces	33,000	Net Square Feet	(Does not include Future Pre-School)		
Total Building Spaces	57,252	Net Square Feet	Built for capacity of 520 (480 in grades 1-5, and 80 in K 1/2 day)		Total Added Area
Total Gross Area	81,789	Gross Square Feet (@70% Efficient)		47,500	34,289

157 GSF/student (at 520 kids)
120 DOE Max Per Student
126 DOE Max Per Student at 95% Utilization

140 GSF/student (at 340 kids)

Space Summary

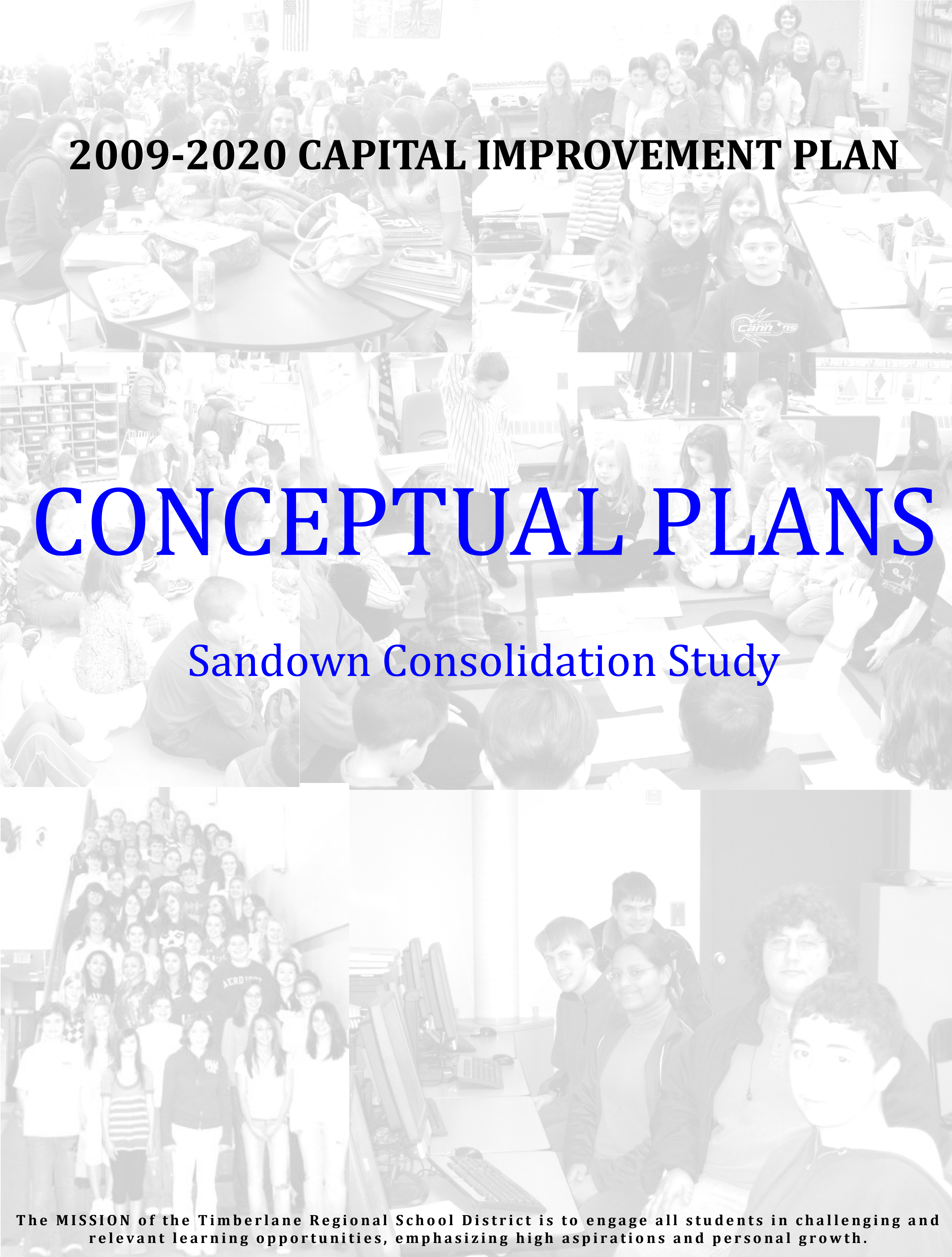
Classrooms*	**22**
Small Group Classrooms	**5**
Physical Ed Areas	**2**
Art Studios	**1**
Music Teaching Spaces	**1**
Specialty	**2**

Existing Summary

Classrooms*	**15**
Small Group Classrooms	**0**
Physical Ed Areas	**1**
Art Studios	**1**
Music Teaching Spaces	**1**
Specialty	**2**

The following spaces are part of the net to gross number

Electrical	**Main Entry**
Mechanical Room	**Other Entrances**
Toilet Rooms	**Main Circulation Areas**

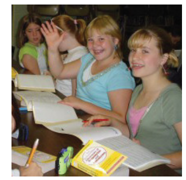


2009-2020 CAPITAL IMPROVEMENT PLAN

CONCEPTUAL PLANS

Sandown Consolidation Study

The MISSION of the Timberlane Regional School District is to engage all students in challenging and relevant learning opportunities, emphasizing high aspirations and personal growth.



Timberlane Regional School District
Atkinson, Danville, Plaistow, and Sandown, New Hampshire

Sandown Elementary Schools
Consolidation Study

Your mission inspires us. Our creativity and knowledge empower you. Together we achieve excellence.

Lavallee Brensinger
ARCHITECTS

Why Consolidate?

-It Better Supports Education

The proposed consolidation will allow the Sandown Primary Schools to provide a more cohesive education for it's students. It will place all programs currently spread across two schools into one location, allowing for better coordination between faculty and students across all grade levels.

The teaching spaces will be much improved over those currently offered at Sandown Central Elementary. The classrooms will be adequately sized with optimum daylighting, improved air quality, and designed to support current teaching strategies. The education areas in Sandown North School will be further enhanced by creating proper support spaces to allow integration of programs such as special education, reading programs, and math coordination. Faculty and staff will have spaces for planning, coordination and meeting areas.

The conceptual designs also address site access and safety issues. The final design shall create improved vehicular circulation and parking. Students shall have safe access to outdoor areas, like the playground and outdoor athletic space, without crossing vehicular accessways.

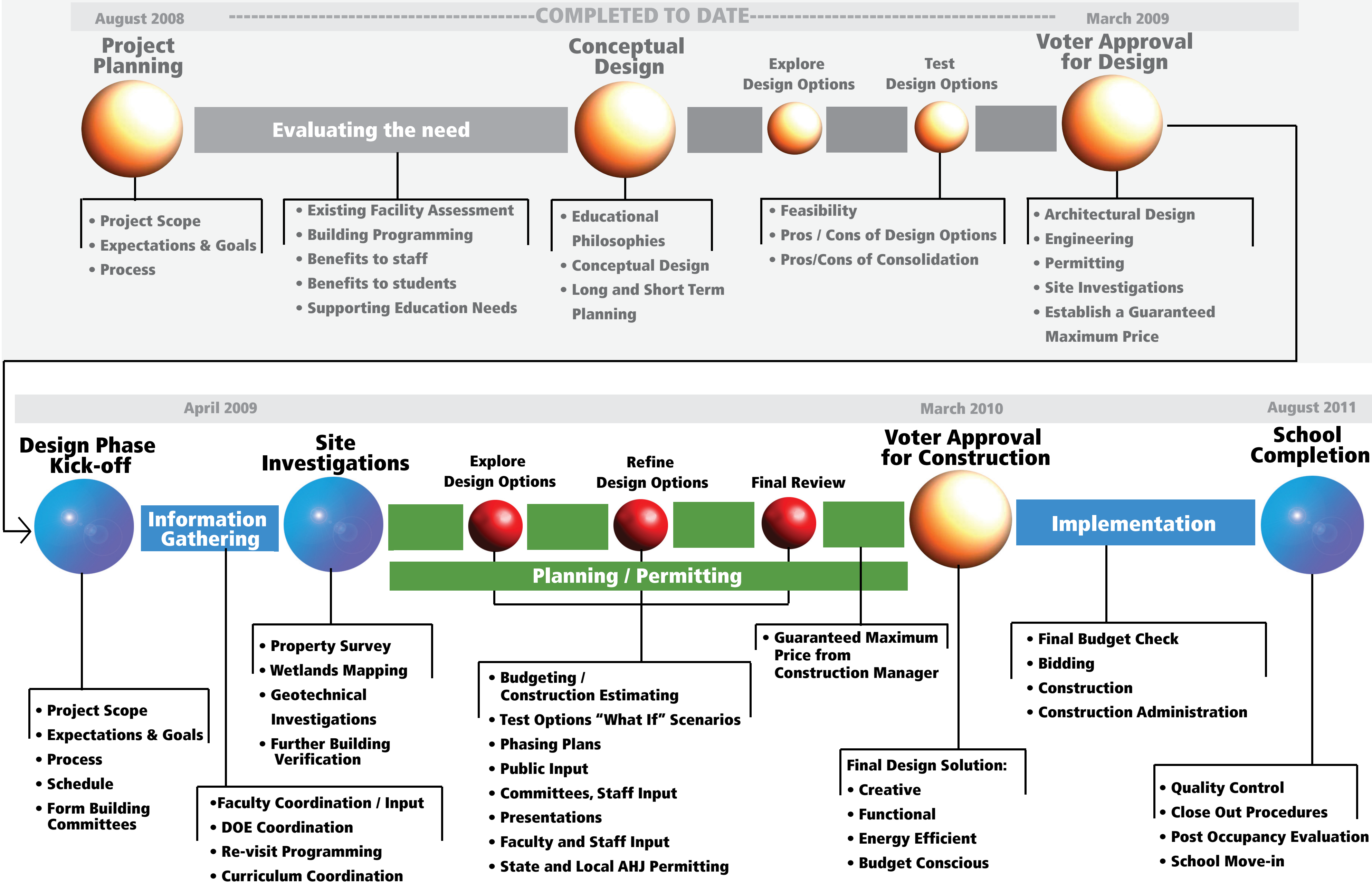
-It Presents a Costs Savings to the District

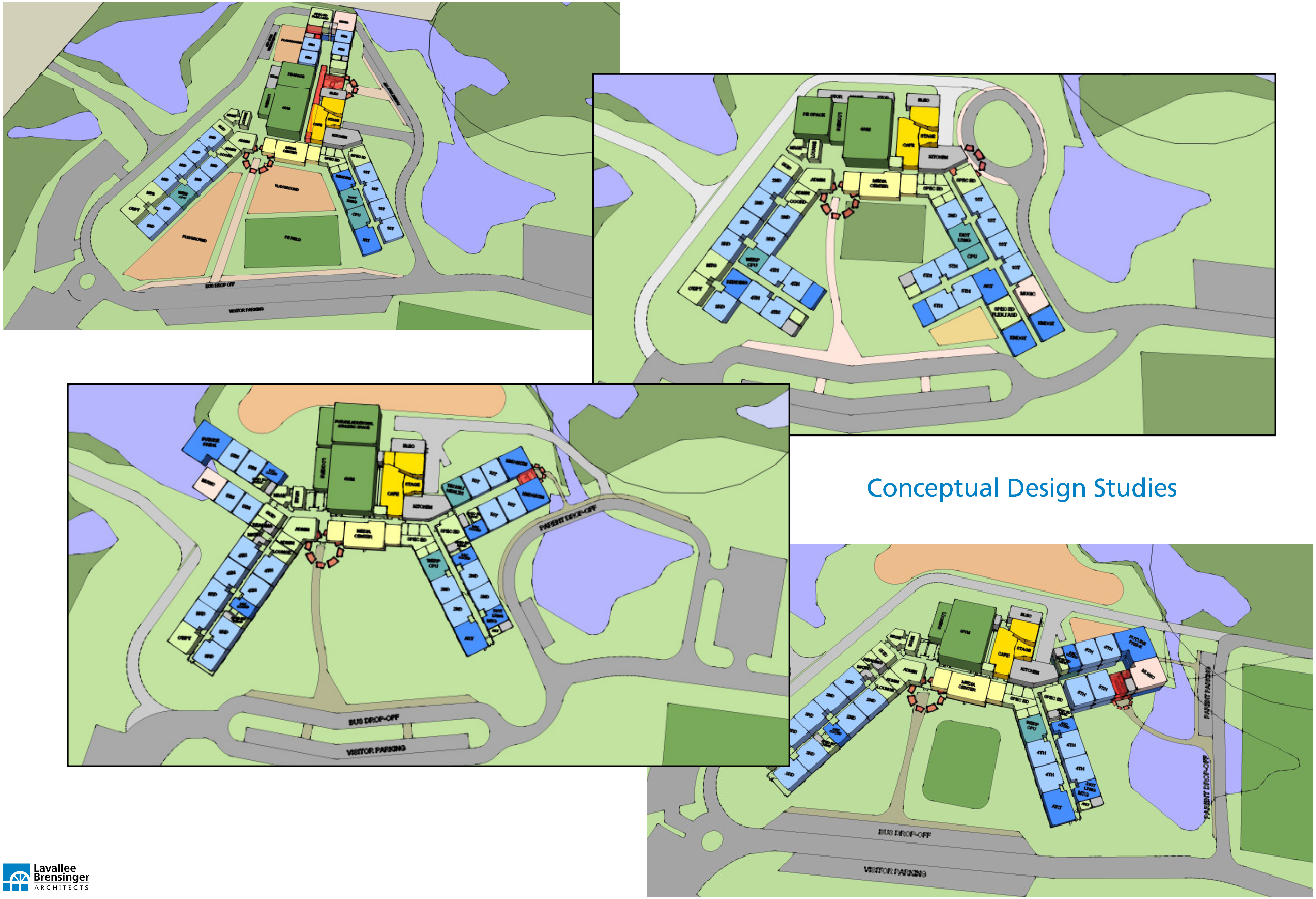
Consolidating the two facilities will create a lower tax burden. Over the course of the anticipated bond, the district could potentially save 2.6 Million dollars. Repurposing of the Sandown Central Facility may result in even further savings. This project will also bring Sandown Primary Schools into better alignment with the rest of the District on a cost-per-pupil basis.

-It Benefits the Community of Sandown

Conceptual plans currently include improved facilites (beneficial to the community) and potentially, additional athletic fields. The consolidation of the schools creates an opportunity for the Sandown Central School to assess how it may best be re-purposed, both for the benefit of the district, and the surrounding community.

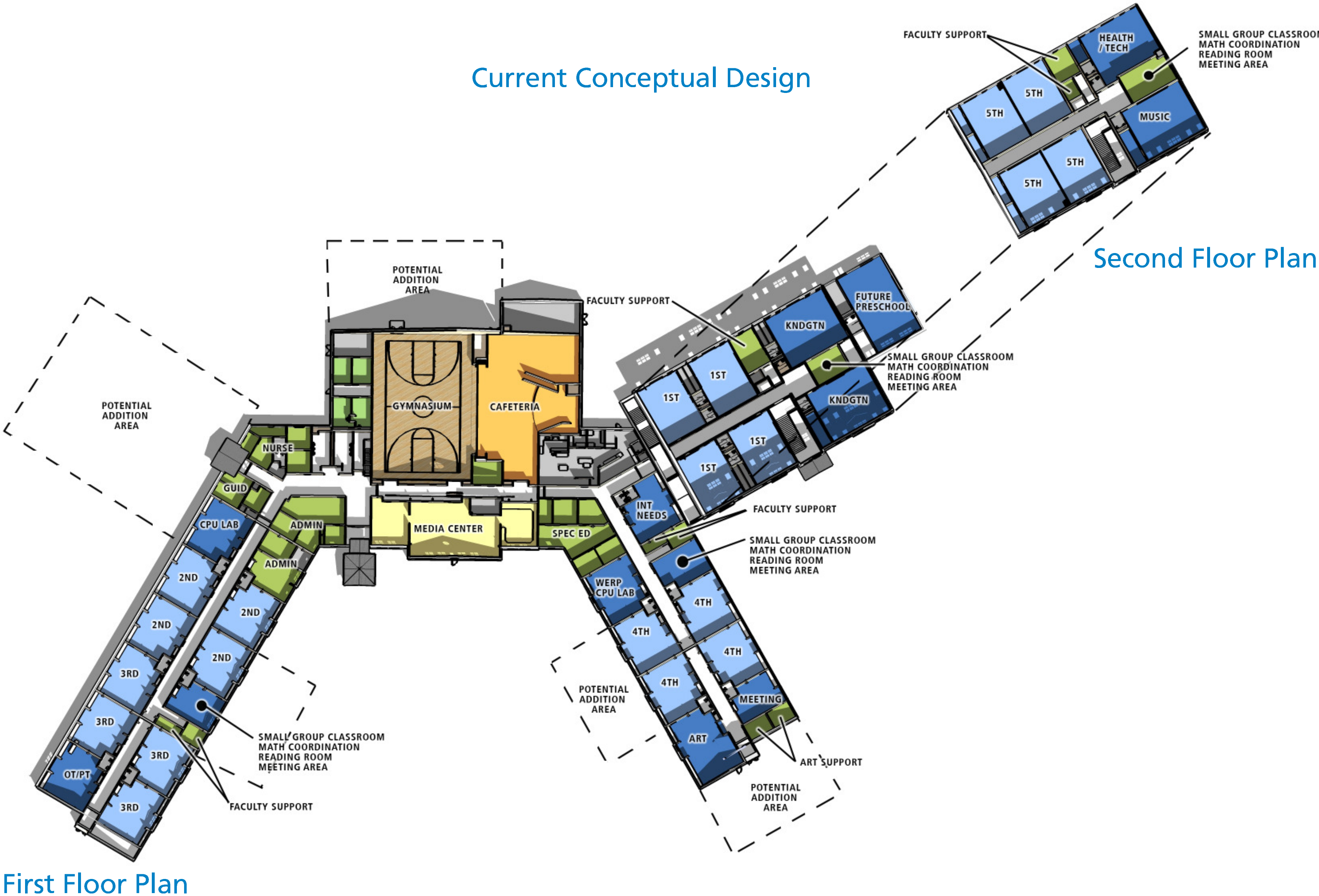
Sandown Elementary Schools Design Process





Conceptual Design Studies

Current Conceptual Design



Current Conceptual Design

Concept Rendering

Concept Rendering

Costs Savings Data

TRSD

DRAFT

DRAFT

Sandown Consolidation Cost Savings

	10 year Bond @ 4.980% interest			State Aid	Net District	Add'l SN Utilities	SC Savings	Savings to
Debt Yr	Principal	Interest	Total	Reimbursement	Cost	(3% inflation factor)		District
Year 0		174,167	174,167		174,167			174,167
Year 1	600,000	285,000	885,000	(300,000)	585,000	36,800	(541,850)	79,950
Year 2	600,000	255,000	855,000	(300,000)	555,000	37,904	(558,106)	34,798
Year 3	600,000	225,000	825,000	(300,000)	525,000	39,041	(574,849)	(10,808)
Year 4	600,000	195,000	795,000	(300,000)	495,000	40,212	(592,094)	(56,882)
Year 5	600,000	165,000	765,000	(300,000)	465,000	41,418	(609,857)	(103,439)
Year 6	600,000	135,000	735,000	(300,000)	435,000	42,661	(628,153)	(150,492)
Year 7	600,000	105,000	705,000	(300,000)	405,000	43,941	(646,998)	(198,057)
Year 8	600,000	75,000	675,000	(300,000)	375,000	45,259	(666,408)	(246,149)
Year 9	600,000	45,000	645,000	(300,000)	345,000	46,617	(686,400)	(294,783)
Year 10	600,000	15,000	615,000	(300,000)	315,000	48,016	(706,992)	(343,976)
Year 11	0	0	0	0	0	49,456	(728,202)	(678,746)
Total	6,000,000	1,674,167	7,674,167	(3,000,000)	4,674,167	471,325	(6,939,909)	(1,794,417)
				Plus Cost avoidance of SC long term Maintenance				(829,900)
					Total Savings after 11 years			**(2,624,317)**

11 Year Savings Distribution by Town based on 2008 tax data:

Atkinson	(272,393)	1,534,174	111,815	(1,646,389)	(272,794)
Danville	(120,298)	677,544	95,699	(1,409,093)	(756,149)
Plaistow	(278,847)	1,570,525	140,937	(2,075,185)	(642,571)
Sandown	(158,362)	891,924	122,875	(1,809,241)	(952,803)
	(829,900)	4,674,167	471,325	(6,939,909)	(2,624,317)

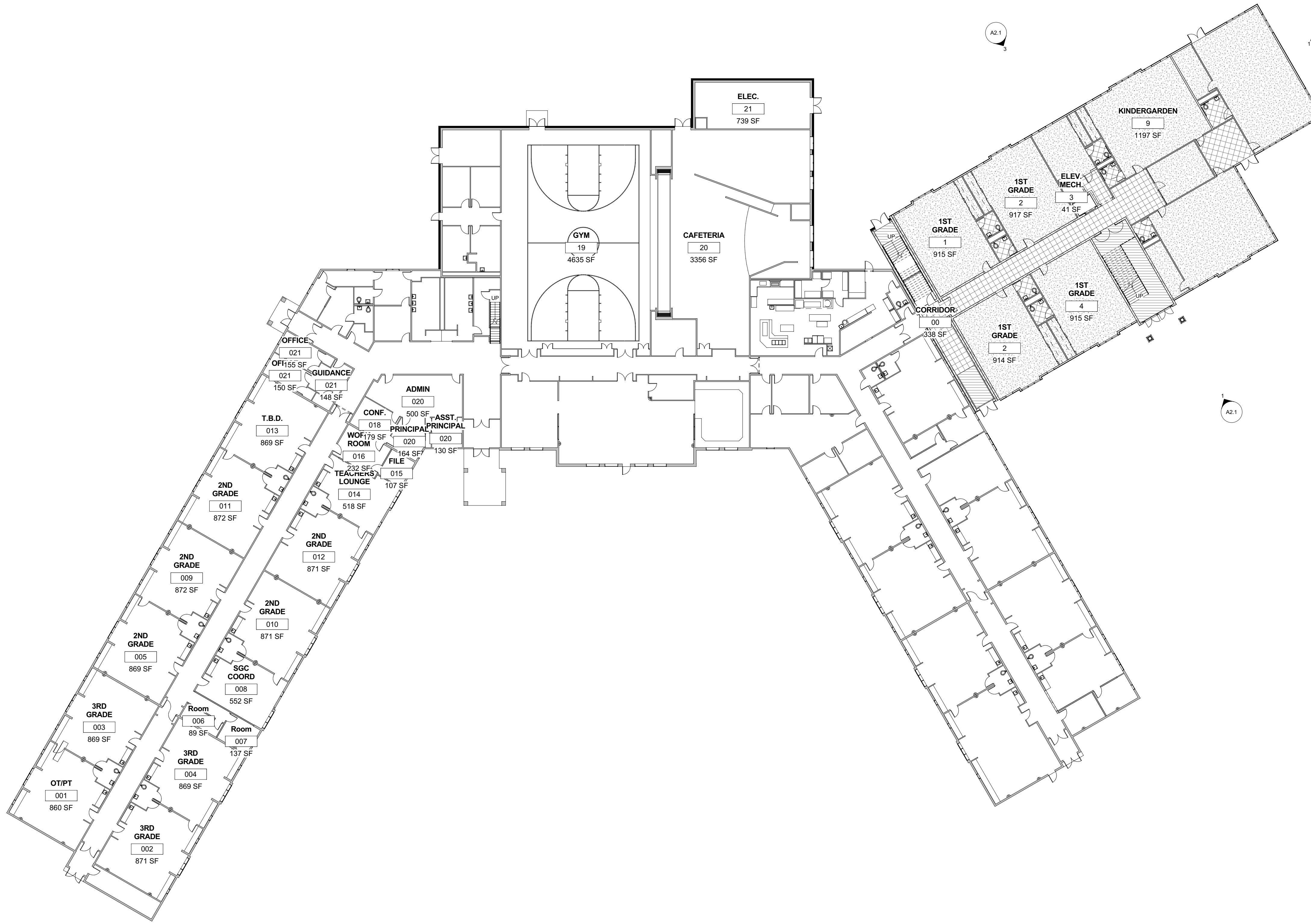
Year 11 and all future years show significant savings after retirement of the construction bond.

Costs Per Pupil

TRSD

2008 Elementary Building Direct Cost per Pupil
(with estimated Sandown consolidation savings)

	Direct Cost	ADM	Direct Cost per Pupil	Rank
Atkinson Academy	$2,459,185	454.8	$5,407.18	1
Pollard	$3,336,643	548.8	$6,079.89	3
Danville	$2,197,217	387.9	$5,664.39	2
Sandown Central	$1,096,777	168.1	$6,524.55	4
Sandown North	$1,892,075	278.1	$6,803.58	5
Total Elem.	$10,981,897	1837.7	$5,975.89	
Sandown Current - Central & North	$2,988,852	446.2	**$6,698.46**	
Sandown Proposed Consolidation	$2,483,802	446.2	**$5,566.57**	
per pupil savings			**$1,131.89**	



1 OVERALL PLAN
1/16" = 1'-0"

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web LBPA.com

TIMBERLANE SCHOOL DISTRICT
SANDOWN NORTH ELEMENTARY SCHOOL
Street, City, State, Zip

DRAWN BY:	Author
PROJECT NO:	0804800
DATE:	12/17/08
REVISED:	XX
SCALE:	1/16" = 1'-0"

CONTENT:
OVERALL FLOOR PLAN

Project Phase
N.F.C.

A1.0

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1 LEVEL 1 - ADDITION
1/8" = 1'-0"

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A B C D E F G H I J

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TIMBERLANE SCHOOL DISTRICT

SANDOWN NORTH ELEMENTARY SCHOOL

Street, City, State, Zip

DRAWN BY: MJA
PROJECT NO: 0804800
DATE: 12/17/08
REVISED: XX
SCALE: 1/8" = 1'-0"

CONTENT:
FIRST FLOOR PLAN

Project Phase
N.F.C.

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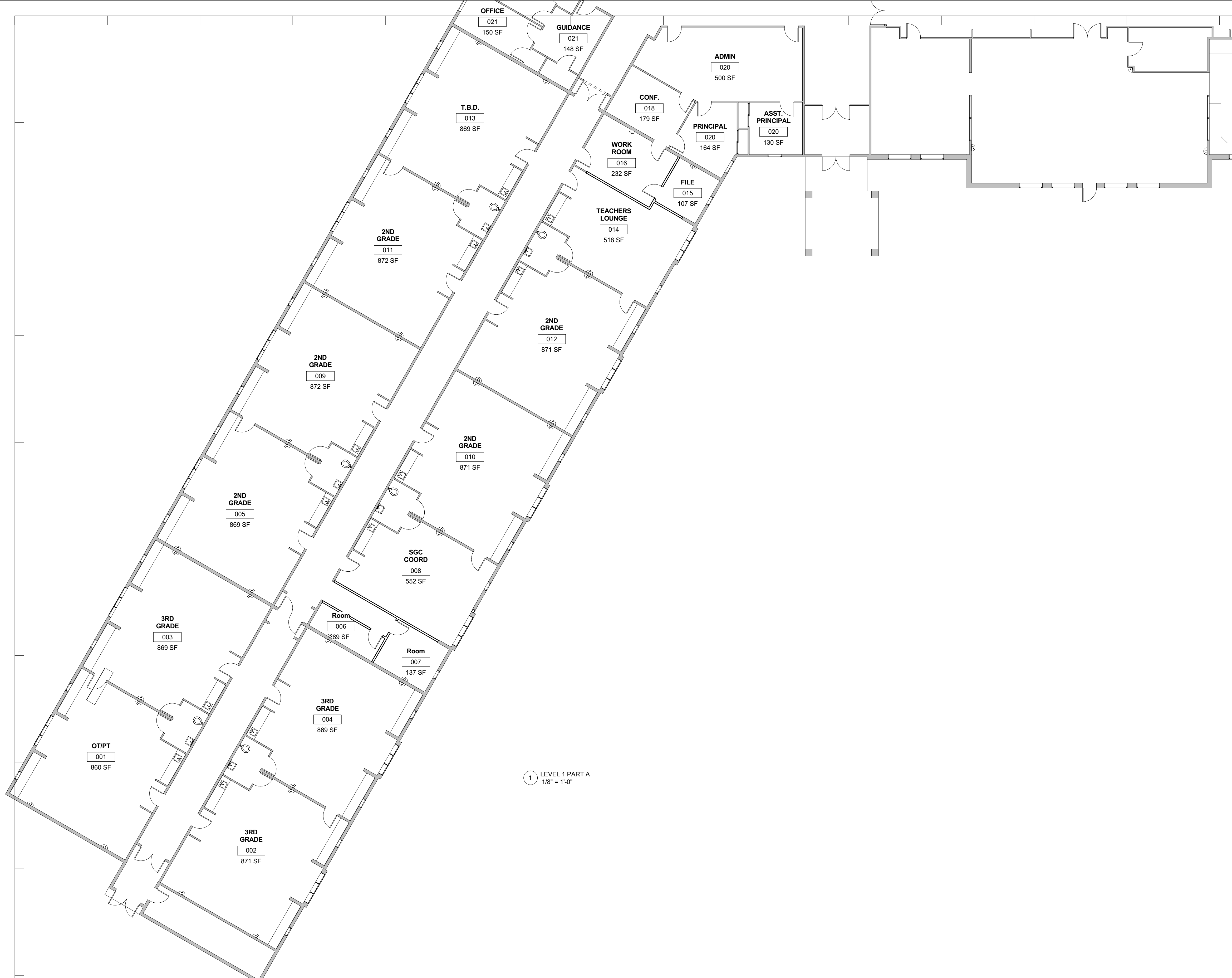

1 LEVEL 1 PART A
1/8" = 1'-0"

A B C D E F G H I J

2 3 4 5 6 7 8 9 10 11 12 13 14

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TIMBERLANE SCHOOL DISTRICT
SANDOWN NORTH ELEMENTARY SCHOOL
Street, City, State, Zip

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DRAWN BY:	Author
PROJECT NO:	0804800
DATE:	12/17/08
REVISED:	XX
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PART A

Project Phase
N.F.C.

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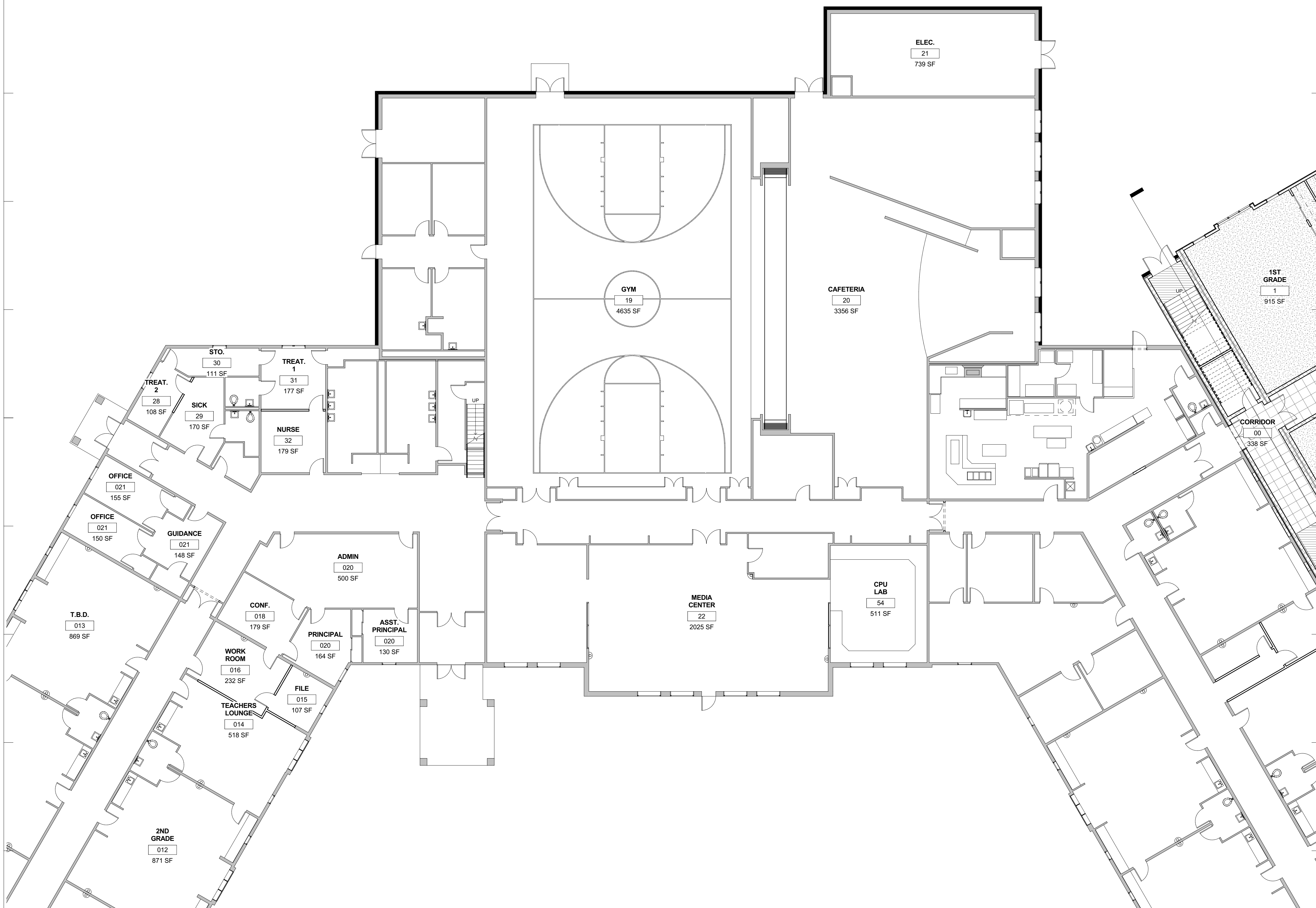

1 LEVEL 1 PART B
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Street, City, State, Zip

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PROJECT NO: 0804800
DATE: 12/17/08
REVISED: XX
SCALE: 1/8" = 1'-0"

CONTENT:
PART B

Project Phase
N.F.C.

A1.0B

1 LEVEL 1 PART C
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SANDOWN NORTH ELEMENTARY SCHOOL
Street, City, State, Zip

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PROJECT NO:	0804800
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REVISED:	XX
SCALE:	1/8" = 1'-0"

CONTENT:
PART C

Project Phase
N.F.C.

A1.0C

1 LEVEL 2 - Addition
1/8" = 1'-0"

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CONTENT:
SECOND FLOOR PLAN

Project Phase
N.F.C.

A1.2

1 Elevation 1 - A
1/8" = 1'-0"

3 Elevation 3 - A
1/8" = 1'-0"

2 3 4 5 6 7 8 9 10 11 12 13 14

A B C D E F G H I J

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TIMBERLANE SCHOOL DISTRICT
SANDOWN NORTH ELEMENTARY SCHOOL
Street, City, State, Zip

N

CONTENT:
EXTERIOR ELEVATIONS

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PROJECT NO:	0804800
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REVISED:	XX
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Project Phase
N.F.C.

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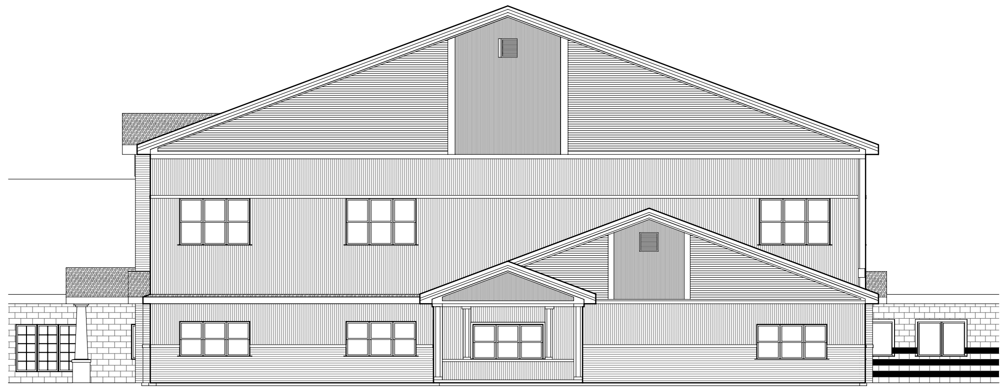

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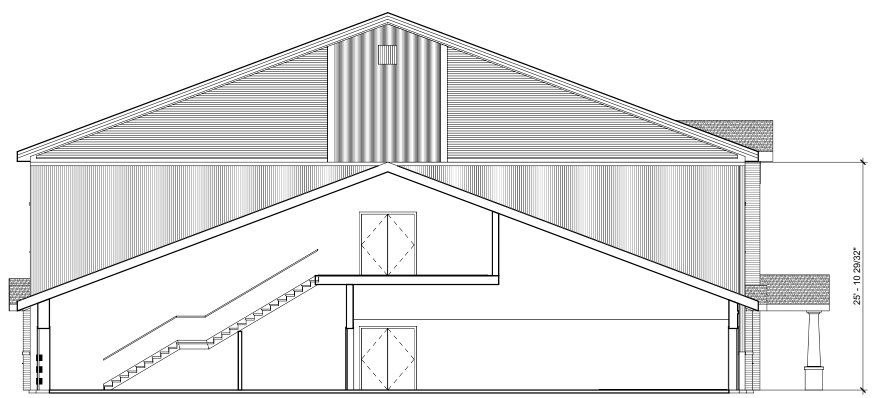

3 SECTION - Stair Add.
1/8" = 1'-0"

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CONTENT:
EXTERIOR ELEVATIONS

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Project Phase
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A B C D E F G H I J
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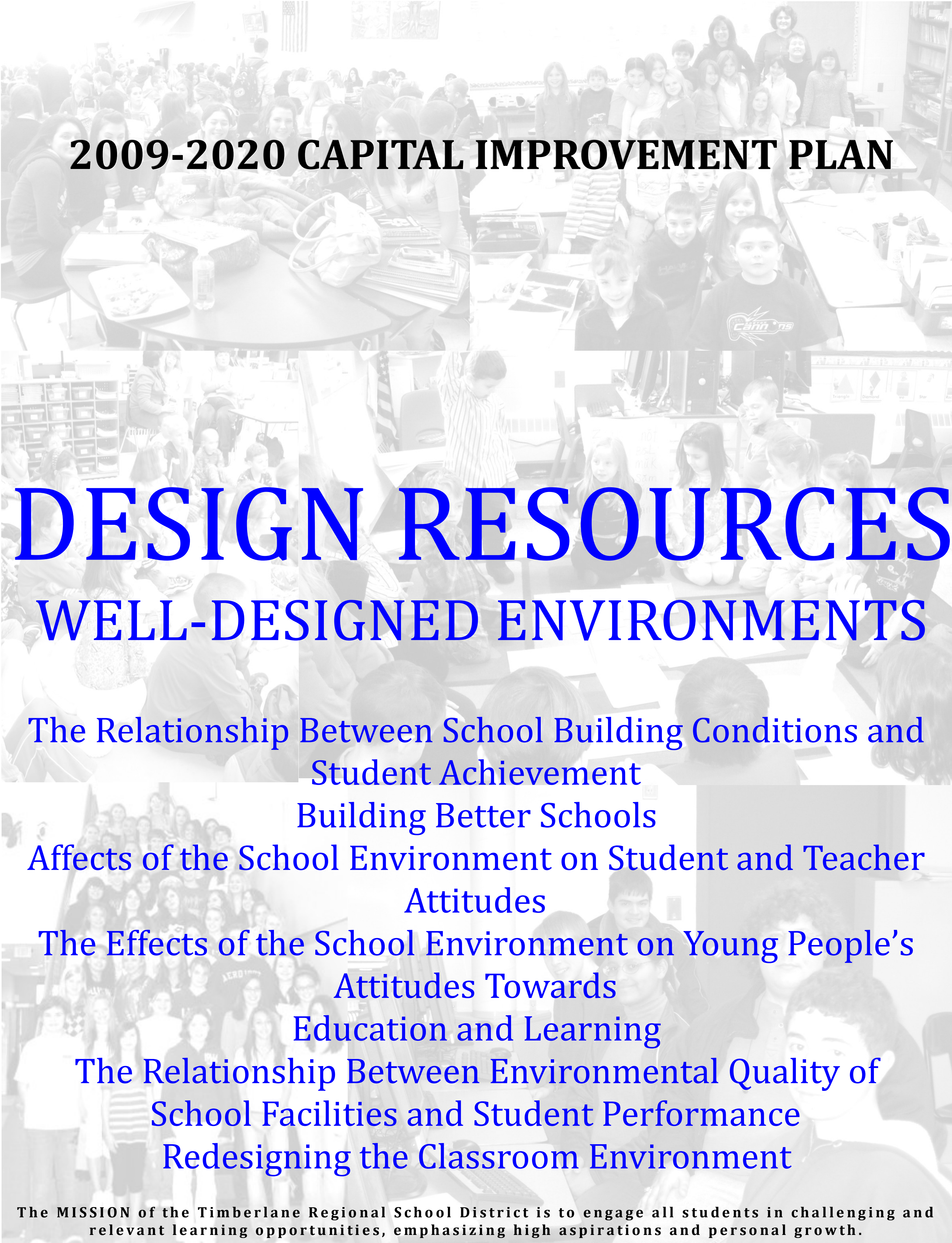

2009-2020 CAPITAL IMPROVEMENT PLAN

DESIGN RESOURCES

WELL-DESIGNED ENVIRONMENTS

The Relationship Between School Building Conditions and Student Achievement

Building Better Schools

Affects of the School Environment on Student and Teacher Attitudes

The Effects of the School Environment on Young People's Attitudes Towards Education and Learning

The Relationship Between Environmental Quality of School Facilities and Student Performance

Redesigning the Classroom Environment

The MISSION of the Timberlane Regional School District is to engage all students in challenging and relevant learning opportunities, emphasizing high aspirations and personal growth.

The Relationship Between School Building Conditions and Student Achievement at the Middle School Level in the Commonwealth of Virginia

By

Calvin C. Bullock

Dissertation submitted to the faculty of the Virginia Polytechnic Institute and State University in partial fulfillment of the requirements for the degree of

Doctor of Education

In

Educational Leadership and Policy Studies

Committee Members:

Glen I. Earthman, Co-Chair

James Craig, Co-Chair

Rose Martin

Linda Lemasters

August 8, 2007

Blacksburg, Virginia

Keywords: School Building Condition, Student Achievement

The Relationship Between School Building Conditions and Student Achievement at the Middle School Level in the Commonwealth of Virginia

Calvin C. Bullock

Abstract

The purpose of this study was to investigate the relationship between school building condition and student achievement as measured by their performance on the Standards of Learning (SOL) examinations at the middle school level in the Commonwealth of Virginia.

Three major data components were used to complete this study. The first component was the condition of the school buildings. To obtain this information, principals were asked to complete the Commonwealth Assessment of Physical Environment (CAPE) assessment instrument. The second component was the percentage of passing scores from SOL examinations for each middle school in the Commonwealth of Virginia. The third component was the socioeconomic status of the students attending the schools as measured by the percentage of students participating in the free and reduced lunch program.

Three research questions were used to examine this topic. The first research question examined the differences in the SOL results of students in school buildings rated as standard and substandard. The second research question examined the differences in

the SOL results of students in school buildings rated cosmetically as standard and substandard. The third research question examined the differences in the SOL results of students in school buildings rated structurally as standard and substandard.

This study found that building condition is related to student achievement. Students performed better in newer or recently renovated buildings than they did in older buildings. The percentage of students passing the Commonwealth of Virginia Standards of Learning Examination at the middle school level was higher in English, mathematics and science in standard buildings than it was in substandard buildings. One of the largest differences in percentage of students passing was in English at 6.10 percentage points. This difference was significant at the .05 level of significance. This is noteworthy because student's ability to read affects all other academic areas. Building age, windows in the instructional area, and overall building condition were positively related to student achievement.

Finally the data from this study were compared to the results of earlier studies that examined high schools in the Commonwealth of Virginia, finding that these results were consistent with the findings of other studies.

Acknowledgements

As I near the end of this most challenging and rewarding endeavor, I must remember those who helped and supported me throughout the process. First and foremost I must first thank God, who is the head of my life, for choosing, using, and sustaining me in the mighty way that He did. It is because of Him and the way He orchestrated my life throughout this endeavor that I had the strength to overcome the desire to quit.

I would next like to thank my wonderful wife, children, and grandchildren for the love, support, and patience they showed over these past four years. Family support for me was absolutely essential to my success in attaining this goal. They encouraged me with the same philosophy that I guided them with over the years, that is to set high expectations and take the necessary measures to live up to them. You cannot rise to low expectations.

I must thank Dr. Glen Earthman who guided me with such grace and dignity. Dr. Earthman, you will never know the confidence you instilled in me in our very first meeting. You also gave me the encouragement and gentle pushes I needed to keep me going when my spirits got down. Your demeanor had the calming but encouraging effect that I needed as I journeyed through this process. Thank you for sharing your knowledge and expertise with me.

Finally I would like to thank my colleagues who supported and encouraged me throughout this process. Their support and understanding was always refreshing and reassuring when times got hard. Thanks again to everyone for your valuable support.

Dedication

This work is dedicated to my family for the love, support, and understanding they have shown over the last four years. My wife gave continuous support and encouragement throughout the entire process. I truly understand how much of a difference a real family can make. Thank you family.

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CHAPTER 1: THE PROBLEM

Introduction

Since the passage of the No Child Left Behind (NCLB) legislation and the requirement for Adequate Yearly Progress (AYP), school systems across the nation along with architects, planners, and facility professionals have been exploring ways to assist their students in improving their academic performance in their daily classroom activities as well as their scores on high stakes, standardized tests (Gertel, McCarty, & Schoff, 2004). This call for higher standards and accountability is coming from the political arena as well as parents and community members. Parents want to feel comfortable that their children will be able to compete at major universities or in the job market upon completion of high school (Lyons, 2001). Taxpayers want assurance that their tax dollars are being used in the most effective and efficient manner (Crampton, Thompson, & Vesely, 2004).

The call for accountability in the Commonwealth of Virginia has mirrored the call nationwide (DeMary, 2004). In the political arena as well as the private sector, accountability and high stakes testing are at the forefront of the education arena. Since their inception in 1998, the Standards of Learning Tests (SOL) have guided teaching in Virginia (DeMary, 2000). School divisions, building administrators and classroom teachers have been doing everything necessary to ensure student success on the SOLs. The areas that have not received a great deal of attention in the minds of administrators are the buildings in which students learn and teachers teach on a daily basis (Gertel, McCarty, & Schoff, 2004).

Several studies investigating the relationship between student achievement, student behavior, and building condition have been conducted over the past 25 years. In Virginia, Cash (1993), Hines (1996), Lanham (1999), and Crook (2006) used similar methodologies to study large samples of elementary and high schools. Their studies showed a definite relationship between building condition and student success at both the elementary school level and the high school level. The relationship between building condition, student achievement, and student behavior for middle school students in substandard or standard rated buildings has not been studied by Virginia researchers.

Statement of the Problem

This study investigated the relationship between building conditions and student achievement at the middle school level in the Commonwealth of Virginia.

Research Questions

Is there a relationship between student achievement and school building conditions at the middle school level in the Commonwealth of Virginia?

1. Is there a relationship between student achievement and building condition in school buildings that are assessed overall as standard or substandard at the middle school level in the Commonwealth of Virginia?
2. Is there a relationship between student achievement and building condition in school buildings that are assessed cosmetically as standard or substandard at the middle school level in the Commonwealth of Virginia?

3. Is there a relationship between student achievement and building condition in school buildings that are assessed structurally as standard or substandard at the middle school level in the Commonwealth of Virginia?

Significance of the Study

Because parents, community leaders, and politicians are continuing to hold school systems more accountable and education administrators at the local, state, and national levels are seeking ways to enhance the ability of students and teachers to be successful, all avenues of assistance must be explored (Crampton, Thompson & Vesely, 2004). Numerous studies have shown a relationship between the condition of the school facility and student achievement. In Virginia the studies conducted by Cash (1993), Hines (1996), Lanham (1999), and Crook (2006) have shown a relationship at both the elementary and high school levels. Research in this area at the middle school level has been identified in a recent study as an area in need of further exploration (Lanham, 1999). Should the results from the study by this researcher be similar to the results from the Cash (1993), Hines (1996), Lanham (1999), and Crook (2006) studies, this would identify all levels of public education in the Commonwealth of Virginia as showing a relationship between the condition of the school facility and student achievement, thus providing financial and administrative decision makers with the information needed to review and revise the necessary funds allocation policies and/or procedures.

Theoretical Model

The idea that the physical environment of schools affects student learning resonates with policymakers, parents, and the general public (Crampton, Thompson & Vesely, 2004). Several national and state studies have shown that relationships exist between building condition and student achievement. Cash (1993), Hines (1996), Lanham (1999), and Crook (2006) are recent studies that focused exclusively on Virginia schools and the relationship that exists between building conditions and student achievement. Lemasters' (1997) research synthesis is further evidence of the association between building condition and student achievement. Lemasters synthesized the results of several different studies and concluded that the condition of the school building is in fact associated with student achievement. Crook's (2006) study of Virginia high schools confirmed the findings of the Cash (1993) and Hines (1996) studies that student achievement is associated with building condition.

The theoretical model for this study, shown in Figure 1 below, was first used by Cash (1993) as a guide in the study of the relationship between building and classroom conditions and student achievement in rural high schools in Virginia. The focus of this study will be the relationship between building condition and student achievement. This study will also examine the relationship between the overall, structural, and cosmetic building conditions and student achievement for males and females. The Cash model suggested that the decisions of leadership concerning the maintenance and custodial staffs are also related to building conditions. If leadership places a high priority on the structural and cosmetic conditions of school facilities, they will provide the fiscal resources in the maintenance and custodial areas to ensure that buildings are maintained in top condition. The Cash model also suggested that the combination of existing school facilities, leadership decisions, and the financial ability of the local school districts account for the condition of the buildings in which students receive instruction on a daily basis.

Theoretical Model Design

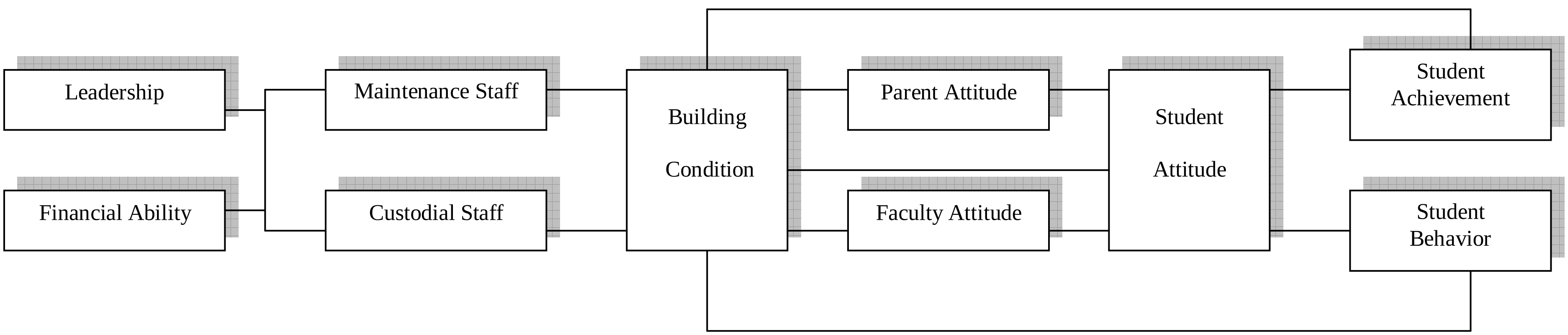

Figure 1

From “*A study of the relationship between school building condition and student achievement and behavior,*” by C. Cash, 1993, unpublished doctoral dissertation, Virginia Polytechnic and State University, Blacksburg. Used with permission.

The financial ability of the local school district is also a major factor in the condition of school facilities. According to Crampton, Thompson and Vesely (2004), few states fund school infrastructure in any meaningful way. “In Virginia, for example, the allocation for maintenance of facilities is very small. The funding is static, as the legislature often lowers the allocations when the budget is tight.” One of the major effects of practices such as this is one called deferred maintenance.

> “Deferred maintenance occurs when the facility owner leaves unperformed planned maintenance, repairs, replacements, and renewal projects due to a lack of resources or a perceived low priority and deferral of the activity results in a progressive deterioration of the facility condition or performance. The cost of the deterioration, including capital cost, operating cost, and productivity losses are expected to increase if the activity continues to be deferred.” *Auditor of Public Accounts Commonwealth of Virginia*, (2005).

According to the Cash model, the condition of the school facilities is indirectly related to student achievement because of its effect on the attitudes of parents, faculty, and students. A well-maintained school building and grounds will send a message to all stakeholders that education is important. This will be the attitude that parents and faculty can pass on to the students. Conversely, a poorly maintained school building and grounds will send the message that education is not important and a negative attitude will be passed on to the students.

Conceptual Framework

The conceptual framework for this study will provide insight into the relationship between building condition and student achievement. First, the relationship between the overall, structural, and cosmetic conditions and student achievement for the entire eighth grade population was examined. Next, the relationship between the overall, structural, and cosmetic conditions and student achievement for the male and female students separately was analyzed. Finally the relationship between the individual components of the building and their relationship to student achievement was investigated.

Limitations

The first limitation of this study is the administration of the Commonwealth of Physical Environment survey instrument. Because it was self administered, principals were asked to complete the instrument about their own school. This could have caused a bias in the responses.

The second limitation was achieving the desired response rate from schools. Many principals may choose not to respond, thereby lowering the number of schools included in the study.

The Standards of Learning (SOL) examination results wasthe third limitation. Schools are required to test a minimum of 95 percent of their students. Therefore, for any given school five percent of the students may not have been tested because of illness, absence, or some other unknown reason. That five percent could cause a school that scored just above the minimum to fail or a school that scored just below the minimum to pass.

The final limitation was the Socio-economic Status (SES) of the students. Qualification for free or reduced lunch is based on household income; however, an application form must be completed and returned to the local school or school district for screening. Some students that would qualify for free or reduced lunch never return the application form; therefore, they were not identified in this category.

Assumptions

The first assumption of this study is that all teachers completed a teacher training program approved by the Commonwealth of Virginia and have been certified and licensed by the Commonwealth to teach. This certification and licensure would indicate that all teachers in the Commonwealth are minimally capable and effective in the classroom.

The second assumption is that all school divisions are using the basic curriculum guides developed by Virginia Department of Education. These curriculum guides have been aligned with the Standards of Learning examinations and are designed to ensure all students in the Commonwealth of Virginia are offered the same basic instruction.

Definitions

1. Deferred Maintenance, for the purposes of this study, occurs when school districts leave unperformed planned maintenance, repairs, replacements, and renewal projects due to a lack of resources or a perceived low priority and deferral of the activity results in a progressive deterioration of the condition of the facility
2. Middle schools, for the purposes of this study, are all schools identified as middle schools by the Department of Education of the Commonwealth of Virginia.

3. Common Assessment of Physical Environment (CAPE), the instrument that was used by local building administrators to determine the condition of their buildings.
4. Overall Building Condition rating is determined by the score obtained from calculating the total number of points based on the responses from the principals to all of the questions on the CAPE used in the scoring process.
5. Structural Building Condition rating is determined by the score obtained from calculating the total number of points based on the responses from the principals to the questions on the CAPE that addressed the age of the building, lockers, ceiling material, science lab equipment, windows, floors, HVAC, lighting, and the roof.
6. Cosmetic Building Condition rating is determined by the score obtained from calculating the total number of points based on the responses from the principals to the questions on the CAPE that addressed the facilities located inside or adjacent to their school building, school grounds, interior and exterior noise levels, interior and exterior wall paint, graffiti, classroom furniture and the sweeping and mopping of the floors.
7. Student Achievement, for the purposes of this study, will be based on student's performance on the SOL examination. The percentage of students passing the SOL in English, mathematics, and science for each building will be used for this study.
8. Socioeconomic Status of the school or the school division, for the purposes of this study, is defined as the ratio of the number of students who receive free or reduced lunch to the number of students in the building or the district.

Organization of the Study

The focus of my study was on the relationship of the condition of school facilities and student achievement as measured by the percentage of eighth grade students passing the SOL examinations in English, mathematics, and science in the Commonwealth of Virginia. Chapter 1 includes an introduction, a statement of the problem, purpose of the study, significance of the study, research questions, theoretical framework, limitations, definitions, and organization of the study.

Chapter 2 includes a review of the literature related to the conditions of school facilities and their relationship to student achievement. The facilities conditions include both structural and cosmetic conditions.

Chapter 3 includes the methodology of the study, background and development of the Commonwealth Assessment of Physical Environment (CAPE) assessment instrument, how the SOLs was used, data gathering, and data analysis.

Chapter 4 includes the findings of the study including an explanation of the data collection and data analysis.

Chapter 5 includes the summary of findings, discussion, conclusion, and implications for further research.

CHAPTER 2: REVIEW OF THE LITERATURE

Introduction

Chapter two gives a review of the research that has focused on the relationships between student achievement and building condition. Several studies have been conducted in various states over the past 30 years investigating the relationship between student achievement and the structural and cosmetic conditions of school facilities. Additionally, several syntheses have been done looking at the research concerning the relationships that exist between student achievement and building condition.

There are some factors that cloud the issue of whether the facilities in which children learn really matter, including the age-old statement that good teachers can teach anywhere, including under a tree. The fact that good teachers can teacher anywhere does not relieve us of our responsibility to provide a safe, secure environment in which all students can learn and all teachers can teach (Moore and Warner, 1998). The question that must be answered, according to Lackney (1999), is “what is the connection between school buildings and education?” Lackney (1999) questions whether it is one of simply housing children and teachers who will get on with their work independent of the condition of the buildings they inhabit? Lackney and other researchers take the view that the factors responsible for student achievement are ecological – they act together as a whole in shaping the context within which learning takes place. The physical environment– the school building – is an undeniably integral part of this ecological context of learning (Lackney, 1999).

Analysis of Research Studies

Studies relevant to the issue of student performance as it relates to building condition includes studies that have examined building condition as it is associated with performance on high stakes testing, using the Commonwealth Assessment of Physical Environment and other measures of building condition. The closing portion of this chapter briefly reviews gender differences in academic performance.

Studies using the CAPE

Cash (1993) examined the relationship between the condition of school facilities and student achievement and behavior. The targeted population for the study was the students in small rural high schools in the Commonwealth of Virginia. Schools that were included in the study were high schools located outside urban areas with a senior class population of less than 100 students. Cash identified a total of 47 high schools to include in her study. Their total student populations ranged in size from 90 to 695 and their senior class populations ranged in size from 12 to 99. The main data elements in the study were school building condition, student achievement, student behavior and the socioeconomic status of the students in the school. School building condition, the independent variable, was determined by data received from the Commonwealth Assessment of Physical Environment (CAPE). The CAPE is a building assessment instrument completed by the building principals giving their evaluation of the school building condition based on the questions asked and the areas covered by the instrument. The information from the CAPE was used to rate buildings overall as substandard, standard, or above standard. The information from the CAPE was also used to rate school buildings cosmetically and structurally as substandard, standard, or above standard. School achievement was determined by using the average mean scaled scores for the Test of Academic Proficiency (TAP). The TAP was a part of the Virginia State Assessment Program that was administered to all 11th grade students each year. Scores in mathematics, reading comprehension, written expression, information, basic composite, social studies, science and complete composite scores were obtained for this study. The basic composite is an average of the scores on the reading comprehension, mathematics, written expression, and using sources of information tests. The complete composite is an average of scores for social studies and science tests and the four tests that comprise the basic composite. Student behavior, for the purposes of this study, was determined by the ratio of the number of expulsions, suspensions, and violence/substance abuse incidents to the number of students in each school. The entire student population was used in determining student behavior. Socioeconomic status (SES) was determined by the percentage of students who did not qualify for free or reduced lunch. Again the entire student population was used in determining the SES of the school. All of the variables were investigated using analysis of covariance, correlations, and regression analysis. Analysis of covariance was used to compare the adjusted means of schools with different building assessment ratings. Socioeconomic status was used as a covariate to adjust the achievement means and behavior rating means for variance because of SES. Achievement score means were compared to behavior rating means and building age using regression analysis. The researcher found that student achievement scores were higher in schools with better building conditions. Student achievement was related more to the cosmetic condition of the building while student behavior was related more to the structural condition of the building. The researcher also found that varying climate control, locker condition, and graffiti were factors that were positively related to student achievement.

Hines completed a study in 1996 similar to the Cash study. He examined the relationship between the condition of school facilities and student achievement and behavior in urban high schools in the Commonwealth of Virginia. Schools that were included in the study were high schools located in metropolitan area with populations over 100,000 and school enrollments over 25,000. These metropolitan areas were obtained by identifying the Metropolitan Statistical Areas (MSA) that possessed the desired population. Those areas, according to Hines, were Roanoke, Lynchburg, Norfolk-Virginia Beach-Newport News, Richmond-Petersburg, Charlottesville, Danville, Johnson City-Kingsport-Bristol, and the District of Columbia (Virginia portion). Hines identified a total of 88 high schools to include in his study. Sixty-six of the 88 high schools participated for a 75 percent participation rate. The main data elements in this study, like the Cash study, were school building condition, student achievement, student behavior and the socioeconomic status of the school. School building condition, the independent variable, was determined by data received from the Commonwealth Assessment of Physical Environment (CAPE). The CAPE is a building assessment instrument completed by the building principals giving their evaluation of the school building condition based on the questions asked and the areas covered by the instrument. The information from the CAPE was used to rate buildings overall as substandard, standard, or above standard. The information from the CAPE was also used to rate school buildings cosmetically and structurally as substandard, standard, or above standard. Student achievement was determined by using the average mean scaled scores for the

Test of Academic Proficiency (TAP). The TAP was a part of the Virginia State Assessment Program that was administered to all 11th grade students each year. Scores in mathematics, reading comprehension, written expression, information, basic composite, social studies, science and complete composite scores were obtained for this study. The basic composite is an average of the scores on the reading comprehension, mathematics, written expression, and using sources of information tests. The complete composite is an average of scores for social studies and science tests and the four tests that comprises the basic composite. To analyze the data, analysis of covariance was used to compare the adjusted means of achievement scores with the three building assessment ratings. Several other analyses were conducted. The composite total achievement means from the TAP were compared between the cosmetic building conditions and the structural building conditions of the two groups of buildings. Behavior rating means were compared among the three building condition categories: overall, structural, and cosmetic building conditions. When comparing the results of the urban and rural high schools, he showed that the scaled scores and percentile ranks were higher in urban schools than rural schools in the schools rated as substandard, standard, and above standard. The greatest difference was found in substandard schools where urban schools were 4.65 points and 7 percentile scores higher than rural schools in science. The greatest difference between the schools in the standard area was in mathematics where scores in urban schools were 8.76 scaled scores and 15 percentile ranks higher than rural schools. For schools in the above standards category, scores for the sources of information subtest for students in urban schools were 12.92 scale score points and 15 percentile ranks higher than rural schools while the mathematics subtest was 11.46 scale points and 19 percentile ranks higher.

Lanham completed a study in 1999 similar to the Cash (1993) and Hines (1996) studies. Lanham's study examined the relationship between the condition of school facilities and student achievement and behavior in elementary school students in the Commonwealth of Virginia. Lanham used a random sample of 300 of the 989 elementary schools in Virginia that housed both third and fifth grades students. Of the schools selected, 197 actually participated. The data elements that were used in the Lanham study were building and classroom conditions, student achievement, the socioeconomic status of the schools, and demographic information related to each school. School building condition, the independent variable, was determined by data received from the Commonwealth Assessment of Physical Environment (CAPE). Although the survey was based on the CAPE used in the Cash (1993) study, some modifications were made such as eliminating those items that related strictly to high school and including items that had been developed concerning the availability and use of technology. The information from the CAPE was used to rate buildings overall as either substandard or standard. Student achievement was determined by use of the results of the 1998 Standards of Learning (SOL) examinations given to all third, fifth, eighth graders and in selected high school courses to assess academic achievement. In 1998, third grade SOL test were administered in English, mathematics, science, and social studies. Fifth grade SOL tests were administered in English reading, literature, and research; English writing; mathematics; science; history and social science; and computer technology. The percentage of students passing each test was used to determine student achievement. The number of students participating in the free and reduced lunch program determined socioeconomic status. The entire student population was used to determine the socioeconomic status of the school using correlations and a step-wise multiple regression analysis to analyze the data. The SOL test results were used as the dependent variable for each multiple regression while the several components of building condition were used as independent variables in the analysis of the data. The finding of this study was that there is a relationship between building condition and student achievement. Some building components were more related to student achievement than others. For instance, air conditioning was a significant variable in third grade English, fifth grade mathematics, and fifth grade technology achievement scores. Other variables found to be significant in one or more of the analyses were ceiling type, frequency of floor sweeping, frequency of floor mopping, connection to a wide-area network, room structure, overall building maintenance, and flooring type. The percentage of students participating in the free and reduced lunch program however, accounted for the largest percentages of variance in English, mathematics, and science SOL scores.

Studies not using the CAPE

Branham (2002) studied the relationship between inadequate school infrastructure and student performance using the 226 schools in Houston Independent School District (HISD) for the 1995-96 school year. The focus of the study was the relationship between problematic school infrastructure and student achievement. According to the author the HISD was the ideal school district for this study. The HISD was represented by schools with groups of students from various ethnic backgrounds. Some schools had a high percentage of students with limited English proficiency (LEP) while other schools had very few LEP students. Additionally there were schools with a high percentage of students from economically disadvantaged families while other schools had a high percentage of students from affluent families. The final reason the HISD was a good school district for this study was that it had wide variety of levels of infrastructure quality in the schools. Data for this study concerning school infrastructure and enrollment were collected from a study conducted by the Texas Performance Review for the 1995-96 school year (Branham, 2002). Additional data for the individual schools were collected from the HISD Profiles, a yearly publication that contains descriptive data for each school. To assess school infrastructure at individual schools, four specific variables were examined: 1) the amount of temporary space schools used, 2) whether or not the school was in need of roof repair, 3) the number of custodians at the school, and 4) the total amount of facility space per student. Ordinary Least Squares (OLS) regression was used to perform the analysis. Three dependent variables, student attendance percentage, drop out percentage, and the HISD performance rating, were used to measured school performance. The HISD performance is a rating of the school based on the students performance on the Texas Assessment of Academic Skills Tests. The author found that the results of the study provided important evidence that school infrastructure has a critical impact on student achievement. Schools with roofs in need of repair, schools that rely heavily on temporary buildings, and schools with understaffed custodial services provide an environment where students are less likely to attend school and more likely to drop out, as well as an environment of scholastic underachievement. A high quality building brings an atmosphere of high student achievement.

O'Neill (2000) investigated the possible impact of school facilities on student achievement, behavior, attendance, and teacher turnover rates at selected Central Texas middle schools in Region XIII Educational Service Center (ESC) area. The principals of all 76 middle schools in the area were sent survey packets and invited to participate. The actual number of principals who participated in the study was 70, a 92 percent participation rate. In addition to the survey data, personal interviews were conducted with ten percent of the principals collecting first hand qualitative data concerning the impact of school facilities on student achievement, behavior, attendance, and teacher turnover rate. Data related to student achievement, behavior, attendance, and teacher turnover rate were also obtained through the Texas Education Agency's Division of Communications and Public Information. The researcher collected data concerning teacher turnover rate for the 1996-97, 1997-98, and 1998-99 school years. Data were also collected concerning the economically disadvantaged, average daily attendance and average membership for the 1998-99 school year. Data concerning student attendance, discipline, average membership and percent of economically disadvantaged students represents all students at those schools. Student achievement data however, which was determined by performance on the Texas Assessment of Academic Skills (TAAS), was limited to eighth graders at the participating schools. The instrument created and used for assessment of the school facilities was called the Total Learning Environment Assessment (TLEA). A large portion of the Guide for School Facility Appraisal, an instrument produced by the Council of Educational Facility Planners, International, as a comprehensive method for measuring the quality and educational effectiveness of school facilities was incorporated into the TLEA. The TLEA also included many original items as a result of research on effective educational facilities. The TLEA contained a total of 82 items. The dependent variables of student achievement, behavior, attendance, and teacher turnover rate were investigated using t-tests to compare means across independent variable categories. The independent categories were the seventeen school facilities (top 25%) with the highest total score on the TLEA compared to the seventeen school facilities (bottom 25%) rated the lowest by total score on the TLEA. The author noted that support data were provided by a series of Pearson product-moment correlations at the question, section, and total score level based on the results of the TLEA responses (O'Neill, 2000). O'Neill (2000) found that for all sections of the Texas Assessment of Academic Skills (TAAS), there was a positive relationship between academic performance and school building condition.

Lair (2003) explored the relationship between school facilities and student achievement as measured by the Texas Assessment of Academic Skills (TAAS) in high performing, high poverty school districts in Texas. This study investigated whether the condition of the school facilities in the Ysleta Independent School District (ISD), located outside El Paso, Texas, was related to the improved student achievement over an eight year period. The Ysleta ISD has a total of 52 school campuses, of which 29 (56 percent) chose to participate: four of the seven high schools, all 11 middle schools, and 14 of the 34 elementary schools. During the 2000 – 2001 school year the student population of Ysleta ISD was 46,394. Of that student population approximately 88 percent, or 40,860, were Hispanic and 73.4 percent, or 34,038, were classified as economically disadvantaged. Three percent of the student population was a combination of African American, Asian, and Native American and less than nine percent of the students were White. The variables examined included building and classroom conditions, the socioeconomic status of the schools, demographics of the schools, schedules of renovation and construction, criteria used to determine priorities regarding district capital expenditures and financial information concerning availability of funds. A variety of techniques was used to collect data on district priorities, sources of funds and building and classroom conditions including the Commonwealth Assessment of Physical Environment (CAPE). Demographic data used in this study was obtained from the Texas Education Agency's (TEA) demographic data collected in 2001 while the data for student achievement came from the TEA 1994 – 2001 administration of the Texas Assessment of Academic Skills (TAAS) test. A mixed method approach was used for several reasons. First, a mixed method approach was deemed most appropriate due to the small size of the sample and the difficulty realized in studying a connection between the condition of school buildings and student achievement. Secondly, the qualitative method allowed the researcher to study information not available from reports and surveys such as capturing the actual words and thoughts of the decision-makers. Finally, the mixed method approach allowed the researcher to deeply investigate the questions concerning how availability of funds impacted priorities regarding maintenance, renovation, and construction of school facilities. In analyzing the qualitative data, interviews were transcribed and analyzed. Themes were determined and checked for the categorization of information. Descriptive statistical analyzes were conducted (means, standard deviations, frequencies, and percentages) and were in addition to multiple regression analysis. The researcher also noted that backward multiple regression analysis determined how much of the variance in the TAAS scores was accounted for by building age and financial disadvantage of the students. The use of multiple regressions and seemingly unrelated regression (SUR) gave insight into why student achievement might change and indicated the probability that school facilities played a part. The finding of this study supported previous research findings that improvement to facilities can be positively related to student achievement. The results of this study also supports the research that suggests that renovated buildings send positive messages to students and that these positive messages are related to their performance.

Lewis (2001) studied 139 Milwaukee public schools and examined the association of building condition with student test scores compared to other influences such as family background, socioeconomic status, attendance, race/ethnicity, and student discipline. The study analyzed the performance on the Wisconsin Student Assessment System Mathematics, Science, Language, and Social Studies tests of fourth, eighth, and tenth grades of each school in 1996, 1997, and 1998. The Construction Control Corporation provided the facility scores from information they had for a study done in 1991. The facility score consisted of four separate measures: an Existing Condition Total, Existing Condition Adjusted, Educational Adequacy Total and Educational Adequacy Adjusted. The Existing Condition Total score was based on direct examinations of the schools that were conducted by teams made up of MPS staff from the Department of Facilities and Maintenance Services and staff from the MPS Program Architect. Each school could receive a score of 1000 for the poorest school to 5000 for an excellent school. All other data were provided by Milwaukee Public Schools (MPS) including information about the characteristics of the students who attended the 139 school such as enrollment by racial/ethnic group, attendance, truancy, and suspension rates, mobility and the percent of students eligible for free or reduced lunches. The Educational Adequacy scores were produced by teams composed of teachers and curriculum specialist from the MPS faculty and staff. The schools were rated in the area of conformity, which was the degree to which they conformed to established design standards for each facility type, and functional performance, which was their adequacy in accommodating current curricula and their capability for alternative use. Conformity, based on established standards, was rated as inadequate, below, equal, above, or exceptional. Functional Performance, also based on established standards, was rated as unacceptable, inferior, average, good, and excellent. The Wisconsin Student Assessment System (WSAS) consists of three sets of standardized tests that are administered to students when they are in fourth, eighth, and tenth grades. The tests reflect student's knowledge in reading, mathematics, language arts (including writing), science, and social studies. These scores, as the facility scores, are converted to standardized scores with a mean of 100 and a standard deviation of 10. The Office of Education Accountability of the Wisconsin Department of Instruction established standards for each grade level and content area that defined four different levels of performance: minimal, basic, proficient, and advanced. The Department of Instruction calculated the percentage of students who performed at or above the proficient level for each school in the state. These percentages were reported for the 139 schools in the Milwaukee Public Schools, and they constituted the student outcome data that were used in the study. The other data elements used in the study were calculated in the following manner. Attendance was the total days of attendance divided by the total possible days of attendance. The denominator for the following four data elements is the total number of students enrolled on the third Friday. Truancy was the number of students absent for either 10 or more consecutive days or 10 or more days in a semester. Suspension was an unduplicated count of the number of students suspended from the school (multiple suspensions for the same student are counted only once per school). Mobility was the total number of students who enter or exited the school after the third

Friday. Free/reduced lunch was the total number of students receiving free or reduced lunch. All of the above elements were converted to standardized scores with a mean of 100 and a standard deviation of 10. Data analysis was completed using multiple regression to provide estimates of the effect of each independent variable upon the dependent while holding the effects of all other variables in the equations constant. This allowed the researcher to isolate the effects of facility condition on test performance while controlling for other factors that might influence student test scores. The strength of the MPS model came from the inclusion of the WSAS Reading test as an independent variable that was regressed against the other WSAS tests as dependent variables. The researcher noted that Reading scores are the most accurate indicators of the ability to do academic work. Including the Reading score as an independent variable increased the explanatory power of the model and the probability of finding statistically significant relationships between the measures of school facilities and the percentage of students in the school that scored at or above the proficient level on the four other tests. The researcher found that student achievement was significantly related to facility condition. One of the surprising findings was that when the differences in the individual ability of students were controlled for, measures of school facilities explained as much of the differences in test performance across schools as indicators of family backgrounds and school attachment. The findings support the findings of previous research that a relationship does exist between student achievement and facility condition.

Pomerantz, Altermatt, and Saxon (2002) studied gender differences in academic performance and internal stress in elementary school children moving into adolescence. The authors noted that girls received higher grades in reading and related subjects, such as spelling and writing, throughout elementary school and into the adolescent years. One of the factors noted by the authors that may cause girls to outperform boys was the tendency for girls to be more concerned than boys were at pleasing adults, such as parents and teachers. Girls concern may increase their effort to do well, thereby enhancing their performance. Boy's performance, on the other hand, may suffer because they are not as concerned as girls are with pleasing adults. Another factor, according to the authors, that may be related to gender difference in performance is that girls and boys approach achievement situations differently. Girls view achievement situations as an opportunity to gain information about their ability. This view held by girls may increase their effort to do well, thereby increasing their performance because they view their performance as an indicator of their ability as a person. Girls therefore are more receptive of evaluative feedback and will use it to improve their performance. Boys on the other hand are more in tune to the competitive nature of achievement situations, leading them to adopt a self-confident approach, making them less likely to see their performance as a reflection on their ability. Because they do not see performance as a reflection on their ability, they are less likely to exert any extra effort to improve their performance.

In their study of students' perception of classroom activities, Gentry, Gable and Rizza (2002) found that girls typically were more motivated than boys. They noted that middle school students, in general, found their classroom activities to be less interesting and enjoyable, with fewer opportunities for choice. Girls however indicated that their class activities were more frequently interesting and enjoyable than the boys did, which could be contributing to the gender difference in achievement. The authors noted that incorporating more interest, choice, and enjoyment in curricular and instructional planning at the middle school level may increase satisfaction with school, motivation, and achievement for boys who have consistently lower scores than girls. It may be, according to the authors, that male middle students are also at risk for disliking school in general, which may be contributing to other problems such as declining achievement, behavior problems, and lack of engagement.

Summary

Several studies in various states have shown over the past 30 years that a relationship between building condition and student achievement does in fact exist. Cash (1993) in her study of rural high schools in Virginia found higher achievement in high schools that were rated above standard in the areas of cosmetics and structure. Hines (1996), in his study, found that building condition had an even greater relationship with student achievement in urban high schools in Virginia. The elementary schools in Virginia were the focus of Lanham's (1999) study in which his results were similar to Cash's and Hines'. O'Neill (2000), Branham (2002), and Lair (2003) all completed studies in different school systems in Texas focused on the relationship between building condition and student achievement. All three researchers found student achievement to be higher in modern recently built school buildings and buildings that had been recently renovated and in good condition than in schools in poor condition. Lewis (2001) found similar results in a study done in the Milwaukee Public Schools investigating the relationship between building condition and student achievement. The potential importance of the physical environment in supporting student achievement should not be ignored (O'Neill, 2000). The information can be used by school officials to positively address the issue of student achievement.

Several studies have also been done that addresses differences in academic achievement as it relates to gender. Pomerantz, Altermatt, and Saxon (2002) noted that one of the factors that may contribute to girls outperforming boys is the tendency for girls to try to pleased adults, such as parents and teachers. Boys do not share that same desire to please adults.

Gentry, Gable and Rizza (2002) found that girls were typically more motivated to do well academically than boys. The authors also found that girls usually found classes to be more interesting than boys and that boys have been known to dislike school in general.

CHAPTER 3: METHODOLOGY

Introduction

Chapter three deals with the methodology of the research. Included in this chapter is a description of the population and the rationale used by the researcher in selecting that population. This chapter also contains a discussion of the data needed for this study. A detailed description of the instrument used to collect the data and why this particular instrument was chosen is also discussed. Finally, the procedures used by the researcher for gathering and analyzing the data are discussed.

Population

The targeted population for this study was eighth grade students attending public schools in the Commonwealth of Virginia. For the purposes of this study, a middle school was defined as one serving students in grades not less than fifth and no higher than eighth. The middle school, however, must serve eighth grade students. According to the Virginia Department of Education website, there are 304 middle schools in Virginia.

Variables

The data needed for this study were information regarding student achievement, the socio-economic status of the students attending each school, and the condition of school facilities. Building condition was determined by an analysis of data obtained through the use of the Commonwealth Assessment of Physical Environment (CAPE) survey.

Student Achievement

Student achievement was determined by using the percentage of eighth grade students passing the spring 2006 SOL Examination in English, mathematics, and science.

The Virginia Department of Education administers, through the local school divisions, the SOL examinations to all eighth students attending public schools.

The four subject areas tested are English, mathematics, science, and social studies. Social studies test scores were not used in this study because of the different methods used to test middle students in social studies. In social studies, school divisions had the option of using one of two methods to test their middle school students. They could use Content Specific History Tests where each grade level was tested on the material from that specific grade level or they could use the Cumulative History Test where only eighth grade students were tested using a comprehensive test covering sixth, seventh, and eighth material. Students had to score a minimum of 400 out of a possible 600 points to earn a passing score on each individual test. A minimum of 70% of the students tested in a school must past all four examinations for that school to receive state accreditation. Achieving the Adequately Yearly Progress (AYP) component of No Child Left Behind (NCLB) is also associated with the number of students who pass the SOL examinations.

The Virginia Department of Education (VDOE) maintains the SOL examination results of all schools in the Commonwealth of Virginia. The tests were developed and scored by Harcourt Testing services. Once the tests were scored, the results were passed on to the Virginia Department of Education. The percentage of students passing the SOL Examinations in English, mathematics, and science was used for this study. The percentage of students passing in each subject area in each building was assessed and the percentage of students passing who attended schools identified as standard was compared to the percentage of students passing who attended schools identified as substandard.

<u>Socio-Economic Status</u>

Socio-economic status was determined by the number of students participating in the free and reduced lunch program compared to the total numbers of students attending the school. This information was obtained from the VDOE website. As in the Crook (2006) study, the percentage of free and reduced lunch participants was used as a covariant when examining the relationship between student achievement and building condition.

Commonwealth Assessment of Physical Environment

Earthman (1998) noted that an appraisal instrument needed to be developed to determine whether school buildings had certain qualities or factors that represented favorable conditions for learning. The Commonwealth Assessment of Physical Environment (CAPE), which was developed to determine whether school buildings had certain qualities or factors that represented favorable conditions for learning, was used in this study. Earthman stated that, in developing the Commonwealth Appraisal of Physical Environments (CAPE) used in Virginia and the subsequent State Appraisal of Facilities in Education (SAFE) used in North Dakota, it was necessary to create an instrument that could adequately discriminate between buildings in poor condition and good condition. Items for the instruments were constructed from most of the categories identified by McGuffey (1982). McGuffey used 15 categories of variables to report the research he included in his analysis. These categories can be found in Table 1 below.

Table 1

Categories of Variables

Physical environment	School building configuration	Programmatic/Physical
School building age	Amount of space	Site size
Thermal factors	Open space	Building utilization
Visual factors	Windowless facilities	Building maintenance
Color and interior painting	Underground facilities	Support facilities
Hearing		Special instruction areas
		Size of school

The categories included in the CAPE are structural, cosmetic, and technological. Specific questions are listed under each category. Twelve items are categorized as structural, fourteen as cosmetic, and four in the area of technology. These categories are shown in Table 2 below.

Table 2

CAPE Items and their Applicable Building Condition Categories

Structural items	Cosmetic items	Technology items
Building age	Interior wall paint	School-wide network
Windows	Interior paint cycle	District-wide network
Flooring	Exterior wall paint	Internet access
Heating	Exterior paint cycle	Cable television
Air conditioning	Adjacent facilities	
Roof leaks	Floors swept	
Locker condition	Floors mopped	
Ceiling covering	Graffiti	
Science lab equipment	Graffiti removal	
Science lab age	Classroom furniture	
Lighting	School grounds	
Building condition	Wall color	
	Exterior noise	
	Building condition	

The structural items are designed to rate the building based on the condition of the actual building. The cosmetic items are designed to determine how the building will be rated based on how appealing and inviting it is both inside and outside. The technology items are used to find out the level of technology that is accessible to staff and students

The CAPE, a 33-item instrument, is self-administered by the individual building principals where he or she is asked to respond to several objective questions concerning the condition of his or her building. Each survey is scored and those scores are used to rate each building to determine if a building was substandard or standard. The CAPE has great internal consistency. A reliability analysis by SPSS showed Cronbach's Alpha to be 823.

The scoring of the CAPE is based upon a numerical value for each item. All items, except six, have three possible responses. The first response for each item with three responses, identified as response A, receives a value of one; the second response, identified as response B, receives a value of two; and the last response, identified as response C, receives a value of three. The exception to this tripartite response system is the scoring for Items 12, 15, 25, 26, 27, and 28. For Item 12 (i.e. an item that addresses the issue of facilities located adjacent to or inside the school building), item 15 (i.e. an item that addresses the issue of graffiti), and the technology questions addressed in Items 26 through 29, the possible responses are no and yes. For Item 12, a "no" response is given a value of zero and a "yes" response receives a value of one. For item 15, a "no" response is assigned a value of two and a "yes" response is given a value of one. For

Items 26 – 29, a “no” response is designated a one and a “yes” response is assigned a value of two. Items 1, 31, 32 and 33 are not included in this scoring process.

The score for a building is derived by adding the values of all the responses to the survey questions. If a school building received the lowest score on all questions, the total score for the building would be 35. The assessment score for a building that received the highest score on every question would be 103. Appendix A summarizes how the CAPE score for each building is derived based on the responses of the principal to the items on the CAPE.

As stated earlier, the CAPE score each building received was used to categorize it as either substandard or standard. These categories were determined by using the quartile method. In this method the researcher divided the total number of buildings into quartiles based on their scores. The buildings in the bottom quartile were rated as substandard and those in the top quartile were rated as standard. The buildings in the two middle quartiles were not used in the study. Cash (1993) in her study of small high school in the Commonwealth of Virginia divided the schools into three categories: substandard, standard, and above standard. She classified the schools in the bottom quartile as substandard, the schools in the middle two quartiles as standard, and the schools in the top quartile as above standard. She found that there was very little variance between the test scores of the students in the standard schools and those in either the substandard or above standard schools. She recommended using the top quartile of schools as the standard category and the bottom quartile of schools as the substandard category of schools.

The overall CAPE score for the buildings could range from a low of 35 to a high of 103. The actual overall CAPE scores based on the responses received ranged from 49 to 78. The structural score for the buildings could range from a low of 12 to a high of 36. The actual structural score ranged from 18 to 35. The cosmetic score could range from a low 20 to a high of 62. The actual cosmetic score ranged from 37 to 60. Finally the technology score could range from a low of four (4) to a high of eight (8). The actual technology score ranged between six (6) and eight (8).

Data Gathering

Three types of data were collected: student achievement performances, socio-economic status, and school facilities condition.

Student Achievement Performance

The Virginia SOL examination is administered to all eighth grade students in Virginia each school year. The September 30, 2005 Virginia Department of Education (VDOE) Fall Membership report showed a total of 95,716 eighth grade students enrolled in Virginia public schools as of that date and all eighth grade students were tested in the four core areas of English, mathematics, science, and social studies. The percentage of eighth grade students passing the SOL Examinations in English, mathematics, and science, which was obtained from VDOE, in the schools where principals completed the CAPE was used in this study.

Socio-Economic Status

Data for the socio-economic status of the school was obtained from the VDOE website. The September 30, 2005, Virginia Department of Education (VDOE) Fall Membership report showed a total of 284,142 students enrolled in the participating schools as of that date. The percentage of students who participated in the free and reduced lunch program at each school which participated in this program at each was used for this study.

School Facilities Condition

This study focused on the 304 middle schools that served students in grades five through eight and several elementary and high schools that served eighth grade students in the Commonwealth of Virginia. In order to collect data from these schools, the permission of the division superintendents had to be obtained. This was done by sending all superintendents an email explaining the purpose of the study and asking their permission to survey the school principals in their respective divisions.

Once permission was granted by the division superintendents to conduct the surveys, the principals of each school in the participating divisions were sent an email in which the research study was introduced and the purpose of the survey explained. The principals were informed that their superintendent was aware of the survey and had granted permission for them to participate. The assessment instrument (CAPE) was sent as a web-link asking principals to complete and return it as soon as possible. For those principals who did not respond, a letter was sent with a copy of the survey attached encouraging them to complete and return it in the self-addressed stamped envelope.

Data Analysis

To analyze the data, the results of the CAPE, the SOL percentage scores, and the percentage of students participating in the free and reduced lunch program at each school was used.

All of the data were loaded in the *Statistical Package for Social Science (SPSS)*. For the CAPE data, each school was loaded using an identification number unique to each school and a response category was established for each item. After the data were analyzed to determine the final score for each school, the schools were ranked from highest to lowest using the CAPE score and the schools were then divided in quartiles. The top 25 percent of the schools were classified as standard and the bottom 25 percent were classified as substandard. The two middle groups of schools were not used in the study because previous studies (Cash, 1993) found that there was very little variance in the test scores of students in the middle two categories and those in the upper and lower categories.

The scores for eighth grade students in English, mathematics, and science were used. The percentage of students receiving passing scores on the SOL Examinations for each subject in each school was used to calculate a student performance score for the schools in the substandard and the standard categories. The scores for the top quartile were compared to the scores for bottom quartile through the use of ANCOVA.

The scores for the 12 structural items on the CAPE were used to identify a different category of schools for top and bottom quartiles. The percentage of students receiving passing scores on the SOL Examinations for each subject from the SOL examinations in each of these schools was used to calculate a student performance score for the substandard and the standard categories. The scores of the schools in the substandard category were compared to the scores of the schools in the standard category through the use of a ANCOVA.

The scores for the 14 cosmetic items on the CAPE were used to identify yet another category of schools for the substandard and standard categories. The percentage of students receiving passing scores on the SOL Examinations for each subject in each of these schools were used to calculate a student performance score for the substandard and the standard categories. The scores of the schools in the substandard category were compared to the scores of the schools in the standard category through the use of ANCOVA.

The socioeconomic status of the school was used as a covariant to adjust for the achievement means. The percentage of students participating in the free and reduced lunch program was used to determine the socioeconomic status of the school. Upon completion of the data analysis, the results were compared to the results of similar studies done in the Commonwealth of Virginia on high schools to determine if there were consistencies in the findings.

CHAPTER 4: FINDINGS

Introduction

Analysis began after receiving the data from the principals who completed the CAPE assessment instrument. The first task was to consolidate the data. Then the calculation of the building condition score for each building based on the principal's responses on the CAPE instrument was completed. Next, the buildings were arranged in ascending order based on the building condition scores. The next task was the division of the schools into quartiles, again based on the building condition score for each school. The schools in the bottom quartile were classified as substandard and those in the top quartile classified as standard. Finally, the percentage of students passing the SOL Examinations for school buildings classified as substandard were compared to the percentage of students passing the SOL Examinations for school buildings classified as standard.

Survey Procedures

In the Commonwealth of Virginia there are 134 school divisions and 304 schools classified as middle schools. An e-mail was sent to the superintendent of each of the 134 school divisions explaining the research and requesting permission to contact the middle schools in their divisions about completing the CAPE assessment instrument. The e-mail to the superintendents was sent out in October 2006. Of the requests sent out to superintendents, 76 representatives from school divisions granted permission for the CAPE assessment instrument to be sent to their principals. Initially only schools classified as a middle school by Department of Education were considered. There are some school divisions, however, that have K-8 elementary schools and 8-12 high schools.

The CAPE assessment instrument was sent to all schools that taught eighth grade during the 2005-2006 school year whose division had granted permission. There were 191 schools that taught eighth grade during the 2005-2006 school year in the divisions that granted permission. Of the 191 schools eligible to participate, 111, or 58 percent, responded.

The collection of data began in October 2006. The CAPE was placed on an e-mail web link using the Survey Monkey data collection system. An e-mail containing the web link was sent to each participating principal with an explanation of the research project and instructions on how to gain access to the CAPE via the web link. Principals were instructed to complete the CAPE on line, click “submit” when completed, and the results would be automatically tallied and stored in the website database. The names of the school division, school, and principal were stored on the database. This would prevent sending out a second request to schools that already had responded. A second request was sent via U.S. mail to the principals that did not respond to the original request. Once the surveys were received, the information was entered into SPSS for analysis of the data.

The schools in the highest and lowest quartiles were then identified as the population of the study. As shown in Appendix B, twenty-nine school buildings (26% of the total) in the lower quartile were classified as substandard with scores ranging from 49-61. Twenty-seven school buildings (24% of the total) in the upper quartile were classified as standard and had CAPE scores ranging from 72-78.

The responses from the principals of the 111 schools to items 2-6, 11, 17-21 and 30 on the CAPE assessment instrument were used to identify the schools in the highest and lowest quartiles based on the structural areas of the buildings. As shown in Appendix

C, the scores of the 29 schools in the lowest quartile ranged from 18 to 25 and these schools were classified as substandard. The highest quartile included 31 schools with scores between 31 and 35; these schools were classified as standard. Then the standard and substandard schools were used in the comparison of percentage of students passing the SOL Examination to evaluate the relationship between the structural building condition and student achievement.

The responses from the principals of the 111 schools to items 7-10, 12-16, 22-25 and 30 on the CAPE assessment instrument were used to identify the schools in the highest and lowest quartiles based on the cosmetic areas of the buildings. As shown in appendix D, the scores of the 28 schools lowest quartile of schools ranged from 37 to 45; these schools were classified as substandard. The highest quartile included 27 schools with scores between 53 and 60; these schools were classified as standard. Once the standard and substandard schools were determined, they were used in the comparison of percentage of students passing the SOL Examination to evaluate the relationship between the cosmetic building condition and student achievement.

The final category addressed by the CAPE was technology. Items 26 – 29 addressed the technology issue in the school buildings. As stated earlier, the goal in analyzing these items was to determine the effect of the availability of technology on student achievement. As with the items in the structural and cosmetics categories, a range of scores for the technology area was obtained by evaluating the responses to items 26 – 29 on the CAPE assessment instrument by the principals of the 111 participating schools. Again, the results from this analysis of the items produced a listing of schools from which the top and bottom quartile were used for comparison purposes of percent of students passing the SOL Examination. The school buildings were much too similar in the area of technology to establish groups of schools with much difference between them.

Item 31 asked for the approximate square footage of their school and item 32 asked for the approximate acreage of the school grounds. Item 33 could be used by the principals to make comments. The overall, structural, and cosmetic ranges are displayed in Table 3.

Table 3

Overall, Structural, and Cosmetic Scores Based on the CAPE Assessment Responses

Building Category	Range	N	Percentage
Overall Standard	72-78	27	24
Overall Substandard	49-61	29	26
Structural Standard	31-35	31	27
Structural Substandard	18-25	27	26
Cosmetic Standard	53-60	26	23
Cosmetic Substandard	37-45	28	25

Achievement and Overall Building Condition

Once the CAPE scores for the buildings were computed and the standard and substandard buildings were determined, the SOL data were used to compare student achievement in the two categories of buildings. The percentage of students who qualified for free and reduced lunch was the covariant used to adjust for socioeconomic status. The percentage of students passing the English SOL was 3.89 percent higher for the buildings classified as standard than the buildings classified as substandard. The percentage of students passing the mathematics SOL was 2.22 percent higher for the buildings classified as standard than the buildings classified as substandard. The percentage of students passing the science SOL was 3.86 percent higher for the buildings classified as standard than the buildings classified as substandard. These results support the results from previous studies that indicated that students perform better in newer buildings than they do in older buildings.

When comparing the scores of males and females in standard category to males and females in the substandard category, the differences in passing percentage were greater for females than males in all three subject areas. The largest differences in passing percentages between the standard and substandard buildings were for females in English and science. The difference in English was 4.59 percentage points. In science the difference was 4.24 percentage points. The difference passing percentage for females in mathematics between the standard and substandard buildings was 2.82 percentage points.

When comparing the passing percentages of males to female in standard buildings, females did better than males in English and mathematics, while males did slightly better than females in science. In the substandard buildings, the passing percentage for males was greater in English and science but better for females in mathematics. The male and female overall scores were compared to determine if building condition had more of an effect on one group than the other. Table 4 below illustrates the differences.

Table 4

A Comparison of Student Passing Percentages on the Standards of Learning Tests in the Overall Building Condition Category

Course	Standard	Substandard	Difference	Significance
English	80.96	77.07	3.89	.807
English-Fem	85.08	70.48	4.59	.386
English Male	76.75	75.31	1.43	.849
Mathematics	76.59	74.37	2.22	.497
Math-Fem	79.79	76.97	2.82	.976
Math-Male	74.12	73.65	0.47	.284
Science	89.48	85.62	3.86	.360
Science-Fem	89.48	85.24	4.24	.284
Science-Male	89.64	86.79	2.85	.675

Achievement and Structural Building Condition

The structural building condition classification addressed the areas of building age, windows, hearting, air conditioning, flooring, roof leaks, lockers, classroom ceiling material, and lighting. There were 12 items on the CAPE that addressed these areas and the effect they may have had on student achievement. The schools were divided into quartiles based on the responses of the principals to the structural questions. The schools in the lower quartile scored between 18 and 25. The school in the higher quartile scored between 31 and 35.

Based on the analysis of the data for the structural items, the passing percentage for students on the English SOL was 5.29 percent higher in the standard schools when compared to the substandard schools. The passing percentage for students on the mathematics SOL was 5.86 percent higher in the standard schools when compared to the substandard schools. The passing percentage for students on the science SOL was 5.16 percent higher in the standard schools when compared to the substandard schools. The largest differences in passing percentages between the standard and substandard buildings were for females in math and science. The difference in math was 7.35 percentage points. In science the difference was 6.22 percentage points. In science the difference in passing percentage of 6.22 was found to be significant at the <.05 level. There was no significant difference in student passing percentages on the Math score. Table 5 below illustrates these differences.

Table 5

A Comparison of Student Passing Percentages on the Standards of Learning Tests in the Structural Building Condition Category

Course	Standard	Substandard	Difference	Significance
English	81.43	76.14	5.29	.819
English-Fem	84.93	80.21	4.72	.120
English Male	77.68	71.93	5.75	.387
Mathematics	78.50	72.64	5.86	.378
Math-Fem	81.50	74.14	7.35	.203
Math-Male	75.75	71.00	4.75	.623
Science	89.87	84.71	5.16	.077
Science-Fem	90.00	83.78	6.22	.046*
Science-Male	89.87	87.35	2.51	.339

*p<.05

Achievement and Cosmetic Building Condition

The cosmetic building condition classification addressed many areas including the paint on the interior and exterior walls, the painting schedule for those walls, facilities located adjacent to the school building, the sweeping and mopping of the floors, graffiti inside and outside the building, classroom furniture, the condition of the school grounds, the color of the walls in the instructional areas, and the location of the school building in reference to major highways, rail ways and airports. There were 14 items on the CAPE that addressed these areas and the effect they may have had on student achievement. The schools were divided into quartiles based on the responses of the principals to the cosmetic questions. The schools in the lower quartile scored between 37 and 45. The schools in the higher quartile scored between 53 and 60.

Based on the analysis of the data for the cosmetic items, the passing percentage for students on the English SOL was 4.77 percent higher in the standard schools when compared to the substandard schools. The passing percentage for students on the mathematics SOL was 6.47 percent higher in the standard schools when compared to the substandard schools. The passing percentage for students on the science SOL was 5.13 percent higher in the standard schools when compared to the substandard schools. The largest differences in passing percentages between the standard and substandard buildings were for females in math at 8.04 percent. The next largest difference in passing percentage was for males in English at 6.28 percent. Table 6 below illustrates these differences.

Table 6

A Comparison of Student Passing Percentages on the Standards of Learning Tests in the Cosmetic Building Condition Category

Course	Standard	Substandard	Difference	Significance
English	81.05	76.28	4.77	.826
English-Fem	85.05	81.14	3.90	.916
English Male	77.00	70.71	6.28	.886
Mathematics	78.89	72.42	6.47	.704
Math-Fem	81.26	73.21	8.04	.317
Math-Male	76.57	71.35	5.22	.855
Science	90.05	84.92	5.13	.449
Science-Fem	89.80	85.42	4.37	.684
Science-Male	90.35	84.71	5.64	.469

Achievement and Individual Building Condition Factors

As shown from the previous tables, the two areas, structural and cosmetic, had varying relationships with student achievement. To get a better idea of how each component was related to student achievement, the components were analyzed individually. The schools that had been previously identified as substandard or standard for overall building condition were used in this analysis. The schools were sorted based on the score of the component being analyzed to determine substandard and standard schools. As stated earlier, all items used in the analysis had either two or three responses. Items 2-11, 13-14, 16-25 and 30 have three possible responses. The first response was weighted as one, the second response was weighted as two, and the third response was weighted as a three. Items 12, 15, and 26-29 had two possible responses. Items 1 and 31-33 were not included in the overall rating of the buildings.

Building Age

The age of the buildings in the study were well represented in all three categories. If the response by the principal for this particular item was weighted as one, the building was categorized as substandard. Buildings whose principals' response to this item was a three made up the standard category. When the two categories of buildings were compared, the percentages of students passing the English SOL subtest was 6.10 percent higher for buildings in the standard category than building in the substandard category. The percentage of students passing the mathematics SOL was 3.28 percent higher in the standard building when compared to the substandard buildings. The percentage of students passing the science SOL was 4.18 percent higher in the standard building when compared to the substandard buildings. Table 7 below illustrates these differences.

Table 7

A Comparison of Student Passing Percentages on the Standards of Learning Tests and the age of the building

Subject	Buildings 19 years old or less	Buildings 40-60 years old or less	Difference	Significance
English	82.25	76.15	6.10	.349
Mathematics	77.40	74.11	3.28	.758
Science	89.70	85.51	4.18	.610

Windows

Eighty percent of the school buildings had windows in at least three-fourth of their instructional area. In comparing the percentages of students in the standard and substandard categories passing the SOL test, the passing percentage in English was 3.48 percent higher in the building in the standard category than in the buildings in the substandard category. The percentage of students passing the mathematics SOL test was 4.18 percent higher in buildings in the substandard category than in buildings in the standard category. The percentage of students passing the science SOL test was 0.87 percent higher in buildings in the standard category than in buildings in the substandard category. Table 8 below illustrates these differences.

Table 8

A Comparison of Student Passing Percentages on the Standards of Learning Tests and the condition of the windows in the building

Subject	Windows in at least ¾ on instructional area	Windows in less than ¼ of the instructional area	Difference	Significance
English	79.28	75.80	3.48	.301
Mathematics	75.42	79.60	-4.18	.464
Science	88.60	87.73	0.87	.713

Floors

Ninety-five percent of the school buildings indicated that they had tile or terrazzo floors in the majority of their instructional area. This group of schools made up the substandard category. Only five percent of the schools indicated that they had carpet, which is considered the ideal flooring in this survey, in the majority of their instructional area. These schools made up the standard category.

In comparing the percentages of students in the standard and substandard categories passing the SOL test, the passing percentage in English was 7.62 percent higher in the building in the substandard category than in the buildings in the standard category. The percentage of students passing the mathematics SOL test was 24.69 percent higher in building in the substandard category than in buildings in the standard category. This difference was found to be significant at the <.05 level. The percentage of students passing the science SOL test was 5.01 percent higher in building in the standard category than in buildings in the substandard category. The small number of schools in the standard category possibly skewed the results in the area. Table 9 below illustrates these differences.

Table 9

A Comparison of Student Passing Percentages on the Standards of Learning Tests and the floor coverings

Subject	Carpet	Tile or Terrrazzo	Difference	Significance
English	71.67	79.29	-7.62	.360
Mathematics	52.67	77.36	-24.69	.003*
Science	87.68	82.67	5.01	.501

*p<.05

Heat

There were a number of buildings in each of the three heat categories. The school rated a one, 24 total, made up the substandard category and the 18 schools rated as a three made up the standard category. The percentage of students passing the English SOL test was 2.15 percent higher in standard category than those in the substandard category. In mathematics 1.46 percent more students pass the SOL test in standard category than in the substandard category. The percentage of students passing the science SOL test was 2.93 percent higher in standard category than those in the substandard category. Table 10 below illustrates these differences.

Table 10

A Comparison of Student Passing Percentages on the Standards of Learning Tests and the condition of the heating system in the building

Subject	Even heat able to control	Uneven heat unable to control	Difference	Significance
English	80.20	78.04	2.15	.804
Mathematics	76.94	75.47	1.46	.686
Science	89.15	86.22	2.93	.543

Air Conditioning

The principals of only four schools indicated that they had no air conditioning in the instructional areas. These schools made up the substandard category. Twenty eight principals indicated that their schools had air conditioning in all instructional areas. These schools made up the standard category. In English 8.25 percent more students pass the SOL test in standard category than in the substandard category. The percentage of students passing the mathematics SOL test was 0.82 percent higher in standard category than those in the substandard category. In science 7.81 percent more students pass the SOL test in standard category than in the substandard category. These differences are illustrated in the table 11 below.

Table 11

A Comparison of Student Passing Percentages on the Standards of Learning Tests and the condition of the air conditioning system in the building

Subject	Air conditioning in all instructional areas and can be well regulated	No air conditioning available	Difference	Significance
English	80.25	72.00	8.25	.435
Mathematics	77.07	76.25	0.82	.720
Science	88.81	81.00	7.81	.150

Interior Paint

This question asked the last time the interior walls, including classroom spaces, was painted and assesses whether this may have an effect on student achievement. The choices were over 15 years ago, between 8 and 15 years ago, and less than eight years ago. Again principals whose response was one formed the substandard category of school buildings while principals whose response was three formed the standard category. The percentage of students passing the English SOL was 3.38 percent higher in the substandard building when compared to the standard buildings. In mathematics 6.47 percent more students pass the SOL test in substandard category than in the standard category. The percentage of students passing the science SOL was 0.48 percent higher in the standard building when compared to the substandard buildings. Table 12 below illustrates these differences.

Table 12

A Comparison of Student Passing Percentages on the Standards of Learning Tests and the condition of the interior paint in the instructional area

Subject	Painted less than eight years ago	Painted over 15 years ago	Difference	Significance
English	79.61	83.00	-3.38	.790
Mathematics	75.83	82.33	-6.47	.575
Science	88.14	87.66	0.48	.452

Interior Paint Schedule

This question asked if the painting of the interior walls in the instructional area was done on a regularly scheduled basis. There were 31 respondents who reported that they had a regular paint cycle for interior walls that was eight years or less. Principals who responded as a one were classified as substandard and principals who responded with a three were classified as standard. The passing percentage for the English SOL was 4.23 percent higher in buildings classified as standard than those classified as substandard. The passing percentage for the mathematics SOL was 7.25 percent higher in buildings classified as standard than those classified as substandard. Finally in the schools classified as standard, 3.37 percent of the students passing were higher than schools classified as substandard in science. Table 13 below illustrates the difference.

Table 13

A Comparison of Student Passing Percentages on the Standards of Learning Tests and the interior painting schedule in the instructional area

Subject	Yes, eight years or less cycle	No	Difference	Significance
English	80.55	76.32	4.23	.754
Mathematics	78.75	71.50	7.25	.295
Science	88.96	85.59	3.37	.703

Exterior Paint

This question asked the last time the exterior walls or windows and trim was painted and assesses whether this may have an effect on student achievement. The choices were over 7 years ago, between 4 and 7 years ago, and within the last four years or no exterior surface requires painting. Again the principals whose response was a one formed the substandard category of school buildings while the principals who responded with a three formed the standard category. The percentage of students passing the English SOL was 2.54 percent higher in the standard building when compared to the substandard buildings. In mathematics 0.63 percent more students pass the SOL test in standard category than in the substandard category. The percentage of students passing the science SOL was 2.20 percent higher in the standard building when compared to the substandard buildings. Table 14 below illustrates these differences.

Table 14

A Comparison of Student Passing Percentages on the Standards of Learning Tests and the condition of the exterior paint

Subject	Painted less than four years ago	Painted over seven years ago	Difference	Significance
English	79.04	76.50	2.54	.826
Mathematics	75.68	75.05	0.63	.526
Science	87.95	85.75	2.20	.714

Exterior Paint Schedule

This question asked if the painting of the exterior walls was done on a regularly scheduled basis. There were 26 respondents who reported that they had a regular paint cycle for exterior walls that was seven years or less or that no exterior surfaces required periodic painting. Principals whose response was a one were classified as substandard and the principals who responded with a three were classified as standard. The passing percentage for the English SOL was 2.73 percent higher in buildings classified as standard than those classified as substandard. The passing percentage for the mathematics SOL was 5.53 percent higher in buildings classified as standard than those classified as substandard. Finally in the schools classified as standard 3.45 percent of the students scored higher than schools classified as substandard. Table 15 below illustrates the difference.

Table 15

A Comparison of Student Passing Percentages on the Standards of Learning Tests and the exterior painting schedule

Subject	Yes, seven years or less or not needed	No	Difference	Significance
English	80.92	78.19	2.73	.536
Mathematics	79.45	73.92	5.53	.571
Science	89.76	86.30	3.45	.656

Roofs

This question used the condition of the interior ceiling as an indicator of leakage or water damage to the roof. The three choices of responses were: (1) ceiling is deteriorating due to water damage and/or water falls in some areas of the facility requiring buckets for water collection, (2) ceiling is currently developing a few stains due to minor leaks, (3) or no visible signs or only a few old water spots in the ceiling. As stated earlier the principals whose response was a one was categorized as substandard. The principals who responded with a three made up the standard category. When the percentage of students passing the English SOL test in the substandard category were compared to the percentages of students passing the English SOL test in the standard category, the percentage of students passing was 2.40 percent higher for buildings in the standard than building in the substandard category. The percentage of students passing the mathematics SOL was 0.21 percent higher in the standard building when compared to the substandard buildings. The percentage of students passing the science SOL was 2.16 percent higher in the standard building when compared to the substandard buildings. Table 16 below illustrates these differences.

Table 16

A Comparison of Student Passing Percentages on the Standards of Learning Tests and the condition of the roof

Subject	Ceiling has no visible stains or only a few old water spots in the ceiling	Ceiling is deteriorating due to water damage and/or water falls in some areas requiring buckets for collection	Difference	Significance
English	77.35	79.76	2.40	.336
Mathematics	76.50	76.71	0.21	.915
Science	85.92	88.09	2.16	.352

Adjacent Facilities

The principals were also asked about facilities located adjacent to or inside their buildings that were being used by or somehow associated with their school. Those facilities included football stadiums, football fields, soccer fields, tennis courts, swimming pools, softball fields, wrestling rooms, and weight rooms. The respondent received one point for each facility located adjacent to or inside their school. If the school did not have any facilities located adjacent to or inside it the respondent received a zero. The scores were computed and sorted in ascending order from one to ten. Schools with a score of two or less were classified as substandard. Schools with a score of five or more were classified as standard. The percentage of students passing the English SOL test in the standard category was 0.85 percent higher those in the substandard category. In mathematics, the percentage of students passing the SOL test was 7.57 percent higher in the substandard than in the standard category. This difference was found to be significant at the <.05 level. The percentage of students passing the science SOL test in the standard category was 0.82 percent higher those in the substandard category. Table 17 below illustrates these differences.

Table 17

A Comparison of Student Passing Percentages on the Standards of Learning Tests and facilities that are either a part of or located adjacent to the school building

Subject	Five or more adjacent facilities	Two or fewer adjacent facilities	Difference	Significance
English	79.75	78.90	0.85	.497
Mathematics	72.90	80.48	-7.57	.028*
Science	88.33	87.51	0.82	.349

*p<.05

Floors Swept

This item looked at how often classroom floors were swept (if wood, tile, or terrazzo or vacuumed if carpeted) to determine its effect on student achievement. Principals in 52 of the 56 schools indicated that the floors were swept daily or more frequent. Those are the schools that were classified as standard. Four principals indicated that the floors were swept at least weekly. This group made up the substandard category. There were no schools that indicated that the floors were swept monthly. The passing percentage of students for the English SOL was 2.26 percent higher in buildings classified as standard than those classified as substandard. The passing percentage for the mathematics SOL was 2.51 percent higher in buildings classified as standard than those classified as substandard. Finally in the schools classified as standard the difference in percent of students passing was1.69 percent higher than schools classified as substandard.

The number of schools in each category may cause the validity of these results to be questionable. Table 18 below illustrates the difference.

Table 18

A Comparison of Student Passing Percentages on the Standards of Learning Tests and how often the floors are swept

Subject	Daily or more frequently	Weekly	Difference	Significance
English	81.00	78.74	2.26	.540
Mathematics	78.33	75.82	2.51	.775
Science	89.00	87.31	1.69	.481

Floors Mopped

This item looked at how often classroom floors were mopped to determine its effect on student achievement. The schools that were mopped daily or weekly, N = 32, classified as standard. The schools that were mopped annually, N = 9, were classified as substandard. The passing percentage for the English SOL was 1.05 percent higher in buildings classified as substandard than those classified as standard. The passing percentage for the mathematics SOL was 6.49 percent higher in buildings classified as standard than those classified as substandard. Finally the percentage of students passing science in the schools classified as substandard was 0.08 percent higher than schools classified as standard. The number of schools in each category may cause the validity of these results to be questionable. Table 19 below illustrates the difference.

Table 19

A Comparison of Student Passing Percentages on the Standards of Learning Tests and how often the floors are mopped

Subject	Daily or weekly	Annually	Difference	Significance
English	78.50	79.55	-1.05	.112
Mathematics	75.93	69.44	6.49	.481
Science	86.81	86.89	-0.08	.176

Graffiti

The principals were asked if they had a problem with graffiti in any areas of their facility. The areas in question were bathrooms, lockers, hallways, classroom wall or doors, other interior areas, exterior walls, exterior walkways or any other exterior surfaces. The two possible responses were yes and no. If the response of the principal was yes they received a one. If the response was no they received a two. The scores were computed and sorted in ascending order. The possible range of scores was 8-16. The standard category was made up of schools with a perfect score of 16. Schools with a score of 15 or less made up the substandard category. The percentage of students passing the English SOL test in the standard category schools was 3.10 percent higher than those in the substandard category. In mathematics, the percentage of students passing the SOL test was 0.24 percent higher in the standard than in the substandard category. The percentage of students passing the science SOL test in the standard category was 3.13 percent higher those in the substandard category. Table 20 below illustrates these differences.

Table 20

A Comparison of Student Passing Percentages on the Standards of Learning Tests and the presence of graffiti inside or outside the building

Subject	None present	Present in some or all areas	Difference	Significance
English	80.19	77.09	3.10	.675
Mathematics	76.06	75.82	0.24	.508
Science	88.74	85.60	3.13	.316

Graffiti Removed

This item looked at how long it took graffiti to be removed. There were five respondents who stated that it took more than a week but less than a month for graffiti to be removed. This group of schools made up the substandard category. The remaining schools made up the standard category. There were no schools who stated they waited until summer maintenance for graffiti to be removed. The percentage of students passing the English SOL test was 4.27 percent higher in standard category than those in the substandard category. In mathematics 2.38 percent more students pass the SOL test in standard category than in the substandard category. The percentage of students passing the science SOL test was 5.07 percent higher in standard category than those in the substandard category. Table 21 below illustrates these differences.

Table 21

A Comparison of Student Passing Percentages on the Standards of Learning Tests and how quickly graffiti was removed

Subject	Less than a week or none present	More than a week but less than a month	Difference	Significance
English	79.27	75.00	4.27	.428
Mathematics	76.18	73.80	2.38	.794
Science	87.87	82.80	5.07	.630

Lockers

Thirty-eight of the principals indicated that over three-fourths of the lockers in their buildings were functional and in good repair. The standard category was comprised of these schools. Sixteen schools indicated that at least three-fourth of their lockers were functional and in good repair while only one principal indicated that most of the lockers in the building were not functional and not in good repair. The substandard category was made up of those 17 schools who indicated that at least three-fourth of their lockers were functional and in good repair or that most of the lockers in the building were not functional and not in good repair. When the percentage of students passing the English SOL test in the standard category were compared to the percentages of students passing the English SOL test in the substandard category, the difference in percentage of students passing was 3.80 percent higher for buildings in the standard category than building in the substandard category. The percentage of students passing the mathematics SOL was 8.60 percent higher in the standard building when compared to the substandard buildings. The percentage of students passing the science SOL was 3.52 percent higher in the standard building when compared to the substandard buildings. Table 22 below illustrates the differences in the percentages.

Table 22

A Comparison of Student Passing Percentages on the Standards of Learning Tests and the condition of the lockers

Subject	Over ¾ of the lockers are functional and in good repair	Most lockers are not functional or not in good repair	Difference	Significance
English	80.14	76.34	3.80	.974
Mathematics	78.88	70.28	8.60	.160
Science	88.58	85.06	3.52	.655

Ceiling Material

This item addressed the materials used in the interior ceilings. The choices were: (1) wood or open beams, (2) plaster or acoustical tiles in at least three-fourths of the instructional spaces, or (3) acoustical tiles throughout the instructional spaces. The principals in schools who indicated three as their response are included in the standard category while principals whose response was one were included in the substandard category. The passing percentage for the English SOL was 4.26 percent higher in buildings classified as standard than those classified as substandard. The passing percentage for the mathematics SOL was 1.89 percent higher in buildings classified as standard than those classified as substandard. Finally in the schools classified as standard, the percentage of students passing were 3.06 higher in science than for students in schools classified as substandard. The number of schools in each category may cause the validity of these results to be questionable. Table 23 below illustrates the difference.

Table 23

A Comparison of Student Passing Percentages on the Standards of Learning Tests and the ceiling material

Subject	Acoustical tiles throughout the instructional area	Wooden or open beam	Difference	Significance
English	79.97	75.71	4.26	.615
Mathematics	76.46	74.57	1.89	.705
Science	88.20	85.14	3.06	.715

Science lab Equipment

This item asked the principal to indicate the utilities available and in usable condition in their science labs. The choices were: sinks and water; sinks, water and electricity; or sinks, water, electricity, and gas. The substandard category consisted of the seven schools whose principal said their labs only had sinks and water. The standard category consisted of the 25 schools whose principal indicated that their labs had sinks, water, electricity, and gas. The percentage of students passing the English SOL test was 2.33 percent higher in standard category than those in the substandard category. In mathematics 6.65 percent more students passed the SOL test in standard category than in the substandard category. The percentage of students passing the science SOL test was 3.50 percent higher in standard category than those in the substandard category. Table 24 below illustrates these differences.

Table 24

A Comparison of Student Passing Percentages on the Standards of Learning Tests and the utilities available in the science lab

Subject	Sinks, water, gas and electricity	Sinks and water	Difference	Significance
English	78.76	76.43	2.33	.126
Mathematics	75.79	69.14	6.65	.832
Science	88.36	84.86	3.50	.300

Age of Science lab Equipment

This item asked the principals to indicate approximately how long it had been since the utilities in their science labs had been updated to current standards. Principals in 22 schools indicated that it had been over ten years since the utilities had been updated. These schools made up the substandard category. Principals in 21schools indicated that it had been less than five years since the utilities had been updated or their building is less than five years old. The standard category consisted of those 21 schools. The percentage of students passing the English SOL test was 5.71 percent higher in standard category than those in the substandard category. In mathematics 4.52 percent more students pass the SOL test in standard category than in the substandard category. The percentage of students passing the science SOL test was 4.93 percent higher in standard category than those in the substandard category. Table 25 below illustrates these differences.

Table 25

A Comparison of Student Passing Percentages on the Standards of Learning Tests and the age of the utilities in the science lab

Subject	Less than five years or building is less than five years old	Over ten years old	Difference	Significance
English	81.66	75.95	5.71	.512
Mathematics	77.57	73.05	4.52	.910
Science	89.61	84.68	4.93	.359

Lights

This item asked the type of lights used in the instructional areas. Responses could be: (1) incandescent; (2) fluorescent-hot; (3) fluorescent-cold. One school indicated the use of incandescent lights and 11 schools indicated the use of hot fluorescent lighting in their instructional areas. These schools made up the substandard category. The percentage of students passing the English SOL test was 2.40 percent higher in standard category than those in the substandard category. In mathematics 3.50 percent more students passed the SOL test in standard category than in the substandard category. The percentage of students passing the science SOL test was 4.05 percent higher in standard category than those in the substandard category. Table 26 below illustrates these differences.

Table 26

A Comparison of Student Passing Percentages on the Standards of Learning Tests and the type of lights in the instructional area

Subject	Fluorescent cold	Fluorescent hot	Difference	Significance
English	79.40	77.00	2.40	.957
Mathematics	76.75	73.25	3.50	.776
Science	88.30	84.25	4.05	.144

Furniture

This item asked the condition of the furniture used in the classrooms. The substandard category of buildings consists of the schools whose principal responded with number one, N = 2, which indicates that the furniture is either facially scarred or functionally damaged. The standard category of buildings consists of the schools whose principal responded with a number three, N = 27, which indicated that all classrooms have furniture which is functionally sound and facially attractive. The percentage of students passing the English SOL test was 6.76 percent higher in substandard category than those in the standard category. In mathematics 5.27 percent more students pass the SOL test in substandard category than in the standard category. The percentage of students passing the science SOL test was 5.38 percent higher in substandard category than those in the standard category. The difference in the number of school buildings in each group was large and this may account for the large negative differences in percent of students passing. Table 27 below illustrates these differences.

Table 27

A Comparison of Student Passing Percentages on the Standards of Learning Tests and the condition of the furniture in the instructional area

Subject	All furniture is functionally sound and facially attractive	Most rooms have furniture that is either facially scarred or functionally damaged	Difference	Significance
English	79.74	86.50	-6.76	.378
Mathematics	76.73	82.00	-5.27	.614
Science	88.62	94.00	-5.38	.274

School Grounds

This item addressed the landscaping, sidewalks, and the overall attractiveness of the school grounds. Principals in 29 buildings indicated that the landscaping and other facilities are attractive and well-maintained at their location. These schools comprised the standard category. When the percentage of students passing the English SOL test in the standard category were compared to the percentages of students passing the English SOL test in the substandard category, the percentage of students passing was 4.54 percent higher for buildings in the standard category than building in the substandard category. The percentage of students passing the mathematics SOL was 0.69 percent higher in the standard building when compared to the substandard buildings. The percentage of students passing the science SOL was 5.50 percent higher in the standard building when compared to the substandard buildings. Table 28 below illustrates these differences.

Table 28

A Comparison of Student Passing Percentages on the Standards of Learning Tests and the condition and appearance of the school grounds

Subject	The landscaping and other facilities are attractive and well maintained	There is no landscaping and sidewalks are either not present or damaged	Difference	Significance
English	79.54	75.00	4.54	.975
Mathematics	77.69	77.00	0.69	.552
Science	88.50	83.00	5.50	.609

Wall Color

In looking at the responses to this item, it shows that only one school indicated that they have dark colored walls in their instructional area and only six indicated that they have pastel colors. Those seven schools made up the substandard category. Forty-eight schools have white or off white walls in the majority of their instructional area. These 48 schools make up the standard category. When analyzing the data, it showed that students in schools in the standard category scored 3.29 percent higher in English than students in schools in the substandard category. In mathematics, students in schools in the substandard category scored 3.17 percent higher than students in schools in the standard category. In science, students in schools in the standard category scored 2.11 percent higher than students in schools in the substandard category. Table 29 below illustrates these differences.

Table 29

A Comparison of Student Passing Percentages on the Standards of Learning Tests and the color of the walls in the instructional area

Subject	White or off white	Pastel or dark color	Difference	Significance
English	79.29	76.00	3.29	.943
Mathematics	75.54	78.71	3.17	.197
Science	87.68	85.57	2.11	.869

School Location

This item addressed how the location of a school building might have an effect on student achievement. Specifically it addressed whether the school being located in or near high aircraft traffic, railroads, major highways or any other loud noise producing environment would effect student achievement. Ten of the respondents said they were in a high noise level area and no measures had been taken to reduce the noise with in the facility. These 10 respondents made up the substandard category. Thirty six responded "no" and made up the standard category. The percentage of students passing the English SOL test in the standard category was 2.60 percent higher those in the substandard category. In mathematics, the percentage of students passing the SOL test was 1.22 percent higher in the substandard than in the standard category. The percentage of students passing the science SOL test in the standard category was 2.42 percent higher those in the substandard category. Table 30 illustrates the differences discussed above.

Table 30

A Comparison of Student Passing Percentages on the Standards of Learning Tests and school location

Subject	No	Yes and no measures have taken to reduce the noise level within the facility	Difference	Significance
English	80.50	77.90	2.60	.634
Mathematics	76.28	77.50	-1.22	.466
Science	88.52	86.10	2.42	.445

Building Condition

This question asked the principals to give their overall assessment of the condition of their building. The choices were below standard, standard, and above standard. Fourteen principals rated their schools as below standard and 28 gave their schools an above standard rating. The substandard category consists of schools assessed as below standard. The schools rated as above standard by their principals made up the standard category. The percentage of students passing the English SOL test in the standard category was 4.51 percent higher than those in the substandard category. In mathematics, the percentage of students passing the SOL test was 4.75 percent higher in the standard than in the substandard building category. The percentage of students passing the science SOL test in the standard building category was 3.98 percent higher than those in the substandard building category. Table 31 below illustrates these differences.

Table 31

A Comparison of Student Passing Percentages on the Standards of Learning Tests and the building condition based on the perception of the principal

Subject	Above standard	Below standard	Difference	Significance
English	81.15	76.64	4.51	.931
Mathematics	76.68	71.92	4.75	.891
Science	89.26	85.28	3.98	.721

CHAPTER 5: SUMMARY OF FINDINGS, DISCUSSIONS, CONCLUSIONS, IMPLICATIONS, AND RECOMMENDATIONS FOR FURTHER STUDY

Introduction

Chapter five will address the research question, “What is the relationship between school building condition and student achievement?” This study was done on eighth grade students in the Commonwealth of Virginia. This chapter will also examine the findings, offer a discussion of the findings, and a conclusion based on those findings. An overall comparison of this study to the Cash (1993), Hines (1996), and Crook (2006) studies that focused on secondary schools in the Commonwealth of Virginia will be done. Additionally some comparisons in specifics areas to studies conducted in other states will also be done. The chapter will conclude with some recommendations for further study.

Summary

The tests results of eighth grade students in the Commonwealth of Virginia who participated in the Virginia Standards of Learning (SOL) Examinations in the 2005-2006 school year were used to examine the relationship between school building condition and student achievement at the middle school level. The theoretical model used by Cash (1993) and other shown in Figure 1 was also used in this study. This study addressed the relationship between building condition and student achievement. The building condition ratings were calculated from the responses provided by the principals on the Commonwealth Assessment of Physical Environment (CAPE). This instrument, designed to determine school building condition in the perception of the principal, has been successfully used in several other studies in the Commonwealth of Virginia. Most notable of these studies were Cash (1993), Hines (1996), and Crook (2006).

The results of the CAPE permit an overall classification of the condition of the building, which can be used to compare student performance. The items on the CAPE also were sub-divided into two major categories, structural and cosmetics. The availability of technology in the school was addressed on the instrument by the addition of four items. The CAPE was sent to all schools in the Commonwealth of Virginia who had given permission that taught eighth grade. These were primarily schools identified as middle schools by the Virginia Department of Education; however, because of the grade configuration in some school divisions, high schools and elementary schools that contained the eighth grade students were included in the study. Once the responses to the CAPE from the schools were received, the information was loaded into SPSS for analysis.

The schools were placed on a continuum of scores from highest to lowest and then were divided into quartiles based on the building condition score calculated from the responses of the principals to the CAPE. The schools in the lowest quartile were classified as substandard and schools in the highest quartile were classified as standard. This division allowed the researcher to determine the relationship between the condition of the building and student achievement by comparing the achievement of students in schools classified as substandard to the achievement of students in schools classified as standard.

The percent of students passing the Standards of Learning (SOL) Examination for the 2005-2006 school year was used to represent student achievement. The SOL results for eighth grade students on the English, mathematics, and science SOL examinations were used in this study. The English score is a composite of the reading and writing SOL scores. The SOL scores for the students were adjusted for socioeconomic status to account for any effect that may have had on the student achievement. This was done through the use of the percent of students participating in the free and reduced lunch program for each school. The free and reduced information was obtained from the 2005-2006 Free and Reduced Price Lunch Program Eligibility Report portion of the Virginia Department of Education's School Nutrition Program (SNP) report.

Findings

The percentage of students passing the Commonwealth of Virginia Standards of Learning Examinations in English, mathematics, and science was used in this study. After the standard and substandard schools were identified, the percent of students passing the SOL examinations in the targeted subject areas for each school was computed. This information was used to compare student academic performance in the standard buildings to student academic performance in the substandard buildings to determine if there was a relationship between condition of the school building and student achievement. This study found that there is a relationship between building and student achievement.

First student achievement in the buildings was compared using the overall school building condition, which included all aspects of the school building in the comparison. Next the items on the CAPE were categorized as structural or cosmetic based on the area of the building or campus they targeted. Then student achievement was compared in the structural and cosmetic categories individually to determine the relationship to student performance. Finally student achievement was compared using the individual items on the CAPE to determine which, if any, individual items were related to student achievement. Comparisons were also made of males and females in the overall, structural, and cosmetic categories to determine if building condition had a stronger relationship with one group more than the other. All of the comparisons mentioned above were done using the *t-test* to compare the percent of students passing the SOL examination in the schools identified as substandard to student performance in schools identified as standard. Both the *t-test* and the Pearson product-moment correlations indicated that the condition of school facilities had a significant association with student achievement when controlling for the SES of the student body.

When the comparison of student achievement using the *t-test* was made for the overall building condition, student performance on the SOLs were better in all three academic areas of the SOL examination in the buildings in the standard category than in those buildings in the substandard category. The difference in passing percentages of students in substandard and standard buildings in English was 3.89, in mathematics it was 2.22, while in science the difference in passing percentages was 3.86. These finding are consistent with the findings of other studies (Lewis, 2001; Earthman and Lemasters, 1996; & Cash, 1993). Lewis stated that "…facility condition may impact student performance more than many social and economic variables." Earthman and Lemasters stated that as facility conditions improve, achievement test scores improved. Cash found in her study that student achievement scores were higher in schools with better building conditions.

To compare student achievement based solely on the items identified on the CAPE as structural, the buildings were given a building condition score based on their responses to the structural items. The buildings were then divided into quartiles based on the structural score and the standard and substandard buildings were identified. The comparison of student achievement in the buildings categorized as substandard to student achievement in the buildings categorized as standard showed that, as with the overall comparison, the percentage of students passing was higher in the buildings categorized as standard in all three academic areas of the SOL. The difference in passing percentages of students in substandard and standard buildings in English was 5.29, in mathematics it was 5.86, while in science the difference in passing percentages was 5.16 percentage points.

A comparison of student achievement also was made using the items on the CAPE that addressed cosmetic aspects of the building. To make this comparison, buildings were assigned a building condition score based on the principal's responses to the cosmetic items on the CAPE. Once the score was obtained, the buildings were divided into quartiles and the substandard and standard buildings were identified. The comparison of student achievement in the buildings categorized as substandard to student achievement in the buildings categorized as standard showed that the percentage of students passing was higher in the standard buildings in all three academic areas. The difference in percent of students passing in substandard and standard buildings in English was 4.77, in mathematics it was 6.47, while in science the difference in passing percentages was 5.13 percentage points.

Another finding related to school building condition and student achievement can be found when examining the differences in male and female performance on the SOLs in the standard and substandard categories. Both genders generally performed better in the standard schools than in the substandard school. A greater percentage of females performed better in English and mathematics while a greater percentage of males performed better in science in the standard schools than those students in substandard schools. The study also showed that building condition appeared to have a greater relationship to female performance than male performance. An examination of the passing percentages in the overall, structural, and cosmetic building conditions showed that the difference in passing percentage was almost always greater for females than males.

In the overall building condition category the differences in percent of students passing in substandard and standard schools in English were 4.59 percent for females and 1.43 percent for males, in mathematics they were 2.82 percent for females and 0.47 for males, and in science they were 4.24 percent for females and 2.85 percent for males.

In the structural area the differences in percent of student passing in English were 4.72 percent for females and 5.75 percent for males, in mathematics the differences were 7.35 percent for females and 4.75 for males, and in science the differences were 6.22 percent for females and 2.51 percent for males. The difference in passing percentage of 6.22 for females in science was statistically significant at the <.05 level.

In the cosmetic area the differences in percent of students passing in English were 3.90 percent for females and 6.28 percent for males, in mathematics the differences were 8.04 percent for females and 5.22 for males, and in science the differences were 4.37 percent for females and 5.64 percent for males.

The largest difference in performance between standard and substandard schools for females occurred in mathematics in both the structural and cosmetics areas. For males the largest differences occurred in English in the structural and cosmetics areas.

An examination of the individual building factors as represented by the 33 items on the CAPE revealed a relationship between student achievement and school building condition in several areas.

1. Building Age. When looking at the comparison of student performance in standard schools (buildings 19 years old or less) and substandard schools (buildings 40 years or older), students performed better in all three academic areas in the standard schools. With the emphasis and wide use of technology in schools today, it would be expected that a higher percentage of students in newer buildings would have better academic performance on SOLs than in older builders because of the amount of technology available. The greatest difference in percent of students passing was 6.10 percentage points in English and 4.18 percentage points in science. The large influence building age has on English performance is noteworthy, as O'Neill noted in his 2001 study, because of the effect reading ability has student performance in other subject areas. Lewis (2001) also noted that "Reading scores are the single most accurate indicators of the ability to do academic work." This finding is consistent with the findings in several other research studies (Cash, 1993; Hines, Earthman & Lemasters, 1996; O'Neill, 2001; Stevenson, 2001; Earthman, 2002), which indicated that students in newer buildings perform at a higher level than students in older buildings. Older buildings usually do not have the main attributes of a modern building that are associated with a positive physical environment conducive to student learning (Earthman & Lemasters, 1996). Many of the building factors that are necessary for proper learning environments are simply absent in older buildings, but are

present and functioning in new buildings (Earthman, 2002). Old buildings cannot compare with new ones in terms of facility quality (O'Neill, 2001).

2. Windows. In comparing student performance in standard versus substandard buildings, the percent of students passing on SOL examinations was higher in English and science in standard schools, which had windows in at least three-fourth of the instructional spaces, than in substandard schools, which had windows in less than one-fourth of the instructional spaces This finding is consistent with the findings of the study conducted by the Heschong Mahone Group (1999) where they found that students in classrooms with the largest window areas progressed 23% faster in reading than those with the least window area. This study also found that students in classrooms where windows could be opened progressed 7-8% faster than those in classrooms with fixed windows.
3. Air Conditioning. When looking at the comparison of student performance in standard schools where buildings that have air conditioning in all academic areas and it can be regulated and substandard schools where buildings have no air conditioning in the academic areas, students performed better in all three academic areas in the standard schools. This finding was similar to findings in this area in most previous studies. The greatest differences in passing percentages were in English and science. This finding is consistent with Cash's study (1993) where she stated that as the quality and level of air conditioning increased, the mean scales also increased.
4. Graffiti. When looking at the relationship between the presence of graffiti and student performance, students scored higher in all academic areas when there was

no graffiti present. This result was similar to findings in previous studies and was expected in the present study. The greatest difference was in English and science where the percent of students passing in standard buildings was compared with percent of students passing in substandard buildings.

5. Lighting. In this study, as in previous studies, when substandard buildings that had predominately hot fluorescent lighting were compared to standard buildings that had cold fluorescent lighting, the percentage of students performing well on their SOL examinations was greater in standard buildings than in substandard buildings in all academic areas. The differences between students in the two categories of buildings in the percentage of students passing the SOL examination were highest in science.
6. School grounds. In this study the responses to this item were consistent with the other items in that the percentage of students passing the SOL examination were higher in all academic areas in the standard buildings than in the substandard buildings. These results would be expected because school and community pride usually had an effect on student performance. This was different from the Crook study where the percentage of students passing the SOL was higher in substandard schools.
7. Building Condition. This item asked the principals to rate their buildings as below standard, standard, or above standard. Students in the buildings rated as above standard by their principal performed better in all academic areas than students in buildings rated as below standard by the principal. The ratings given to buildings are strictly the opinion of the principals, but based on the performance of the

students on the SOLs, it would appear that their opinions are correct and the responses to this item would indicate that building condition does have an effect on student achievement. The finding in this study of the relationship between how principal rate their building and student achievement is consistent with the findings in the Stevenson (2001) study which stated that most building administrators believed that the condition of the school facility has a direct connection with how well students perform academically. The Stevenson study also found that the principals felt that if the condition of the facilities are poor, they must spend valuable time trying to correct problems, thereby having less time to devote to the instructional program, interacting with teachers, and being in classrooms

Conclusion

The data from this study show that there is a positive relationship between school building condition and student achievement at the middle school level in the Commonwealth of Virginia. The differences in percentage of students passing the Standards of Learning Examinations in standard and substandard school buildings are higher in some areas of the SOL Examination than others, but there is a definite overall positive relationship between school building condition and student achievement. The data also showed a positive relationship between the structural and cosmetic conditions of the building and student achievement. Finally the data from this study showed that the differences in passing percentages varied between females and males. Generally the differences in passing percent appeared to be higher among females than male in most areas.

An examination of some individual aspect of buildings showed that some areas in the building influenced student achievement more than others. The age of the buildings had an influence on reading. This is an area of particular interest because of the effect reading has on student success in other academic areas. As stated earlier, the results of this study supports the findings of other studies showing that there a relationship between building condition and student achievement.

Discussion

The data in this study clearly show that a positive relationship exist between school building condition and student achievement. That relationship is stronger among females on some subtests and stronger among males on other subtests. The greatest difference in passing percentage occurred among females in mathematics when comparing students in standard schools to substandard schools in the cosmetic category. The greatest difference in passing percentage occurred among males in English when comparing standard schools to substandard schools in the cosmetic category.

In the overall building condition the greatest difference in passing percentage, 4.59 percentage points, occurred in English among female students when comparing student performance in standard schools to substandard schools. When looking at the structural condition of schools, the greatest difference in passing percentage, 7.35 percent, occurred in mathematics among female students when comparing student performance in standard schools to substandard schools. When comparing students in standard schools to students in substandard school in the cosmetic conditions the greatest difference in passing percentage, 8.04 percent, occurred in mathematics among female students.

It should be noted that when looking at the total student population, not separating male and female, students performed better in standard schools than students in substandard schools on all subtests. The greatest difference in the percentage of students passing the SOLs between standard and substandard buildings in the overall school condition was 3.89 percentage points in English. In the structural category the greatest difference, 5.86 percentage points, occurred in mathematics. In the structural category the greatest difference, 6.47 percentage points, also occurred in mathematics.

These results show that many schools are who missing state accreditation or failing to meet the minimum requirements for No Child Left Behind (NCLB) by a few points may be the victims of poor building conditions.

Comparison to Previous Research Studies

A comparison was done between this study and the Cash (1993), Hines (1996), and Crook (2006) studies. It should be noted that all of these studies were done at the high school level. It should also be noted that the Cash and Hines studies used the Test of Academic Proficiency to measure student achievement and that those studies used percentile ranks to record differences. The Crook study, like this study, used the percentage of students passing the Standards of Learning Examination to measure student achievement. Although these differences did exist, there were many similarities in the results. All of the studies showed that a relationship does exist between school building condition and student achievement.

When making the comparison of this study with the previous studies, a major consideration that must be kept in mind is that this study was done at the middle level and all of the previous studies were at the high school level. Another consideration is that the

SOL results show the percentage of students that passed that test at each individual school. Cash and Hines used the Tests of Academic Proficiency, which are national norm referenced standardized tests. The mean score of these tests were based on national passing means.

In comparing the results of this study and the previous studies on schools in the Commonwealth of Virginia, several similarities were noted. In this study the passing percentage was higher among students in standard schools than students in the substandard schools in all academic areas. This was true for the overall, structural, and cosmetics categories.

In the Cash (1993) study all components of the TAP achievement percentile ranks were higher in the standard schools than in the substandard schools in the overall building condition. The Hines (1996) study also showed that TAP achievement percentile ranks were higher in the standard schools than in the substandard schools. In the Crook (2006) study, where the percentage of students passing the SOLs were used to measure student achievement as the current study did, the percentage of students passing the SOLs were higher in the standard buildings than in the substandard buildings in English and Algebra II. In Algebra I and Geometry the percentage of students passing the SOLs were higher in the substandard buildings than in the standard buildings. In this study the percentage of students passing the SOLs were higher in the standard buildings than in the substandard buildings in all three academic areas. Table 32 illustrates the comparison of the studies.

Table 32

Comparison of differences in achievement percentile rank scores and percent of students passing the SOL tests in standard and substandard buildings in the overall building condition category

Subject	Cash (1993) (TAP)	Hines (1996) (TAP)	Crook (2006) (SOL)	Bullock (2006 SOL)
Reading Comprehension	+4	+15	6.6	
Math Application	+4	+17		2.22
Language/Writing	+2	+9	5.5	3.89*
Sources of Info	+4	+13		
Basic Composite	+4	+13		
Social Science	+3	+11		
Science	+5	+9		3.86
Total Composite	+5	+14		
Algebra I			-1.5	
Algebra II			2.5	
Geometry			-1.1	

*English SOL subtest includes both reading and writing

In the Cash (1993) study all components of the TAP achievement percentile ranks were higher in the standard schools than in the substandard schools in the structural building condition. The Hines (1996) study also showed that TAP achievement percentile ranks were higher in the standard schools than in the substandard schools. In the Crook (2006) study, the percentage of students passing the SOLs was higher in the standard buildings than in the substandard buildings in English, Algebra II, and Geometry. The percentage of students passing the SOLs in Algebra I was again higher in the substandard buildings than in the standard buildings. In this study the percentage of students passing the SOLs were higher in the standard buildings than in the substandard buildings in all three academic areas. Table 33 illustrates the comparison of the studies.

Table 33

Comparison of differences in achievement percentile rank scores and percent of students passing the SOL tests in standard and substandard buildings in the structural building condition category

Subject	Cash (1993) (TAP)	Hines (1996) (TAP)	Crook (2006) (SOL)	Bullock (2006 SOL)
Reading Comprehension	+4	+8	6.7	
Math Application	+4	+9		5.86
Language/Writing	+2	+5	7.0	5.29*
Sources of Info	+4	-1		
Basic Composite	+4	+7		
Social Science	+3	+7		
Science	+5	+7		5.16
Total Composite	+5	+9		
Algebra I			-2.8	
Algebra II			1.3	
Geometry			1.2	

*English SOL subtest includes both reading and writing

In the Cash (1993) study all components of the TAP achievement percentile ranks were higher in the standard schools than in the substandard schools in the cosmetic building condition. The Hines (1996) study also showed that TAP achievement percentile ranks were higher in the standard schools than in the substandard schools. In the Crook (2006) study, the percentage of students passing the SOLs was higher in the standard buildings than in the substandard buildings in English and Algebra II. As in the overall building condition, the percentage of students passing the SOLs in Algebra I and Geometry were higher in the substandard buildings than in the standard buildings. In this study the percentage of students passing the SOLs were higher in the standard buildings than in the substandard buildings in all three academic areas. Table 34 illustrates the comparison of the studies.

Table 34

Comparison of differences in achievement percentile rank scores and percent of students passing the SOL tests in standard and substandard buildings in the cosmetic building condition category

Subject	Cash (1993) (TAP)	Hines (1996) (TAP)	Crook (2006) (SOL)	Bullock (2006 SOL)
Reading Comprehension	+4	+5	6.6	
Math Application	+4	+4		6.46
Language/Writing	+2	+4	5.5	4.76*
Sources of Info	+4	0		
Basic Composite	+4	+5		
Social Science	+3	+4		
Science	+5	+5		5.12
Total Composite	+5	+6		
Algebra I			-1.5	
Algebra II			2.5	
Geometry			-1.1	

*English SOL subtest includes both reading and writing

Study Concerns

A major concern of this study is the Standards of Learning (SOL) data used in the study. The percentage of students passing can be misleading because the actual number of students that took the test is not included. Some comparisons may be between a school that has an eighth grade class of 400 students and a school that has an eighth grade class of 50 students. Additionally ninety-five percent of the eligible student population is required to test in a given school. This means a significant number of students, five percent, could be left out in a large school or school division versus a small number in a small school or school division.

Another concern is the use of percentage of students passing the SOL tests versus use of the actual scores on those tests. Scale scores would have provided more accurate data because they are scores of actual students and not a group of students.

The accuracy of the data being reported by the principals is another concern. Some principals may not want to reveal the actual condition of their school because of a sense of loyalty or pride in their school. Some principals may not want to let other people know the poor condition of their school building.

In looking at studies that addressed the effect of windows on student achievement, the effect of daylight and skylights were addressed in some studies. The study conducted by the Heschong Mahone Group (1999) found that students performed better in instructional areas that had more skylights and daylight. The CAPE instrument does not address the issue of daylight and skylights. An item could be added to the CAPE to address the area of daylight and its effect on student achievement.

The final concern is the accuracy of the comparison of the results of this study to the studies of Cash (1993), Hines (1996), and Crook (2006). The main concern is that all of those studies were at the high school level and this study was at the middle school. The other concern is that the Cash and Hines studies are 14 and 11 years old respectively. Many school buildings could have been replaced or updated during that time. The definition of what would have been considered a good or acceptable school building 11-14 years ago is not what would be considered a good or acceptable school building today. The expectations of parents and school officials for school facilities have also changed.

Finally the tests used by Cash and Hines, Test of Academic Proficiency (TAP), were also different from the SOL Examinations. This makes the comparison somewhat difficult.

Recommendations for Further Study

The following recommendations for further studies are offered.

1. Conduct a study at the middle school level of school building conditions and student achievement in schools in urban/suburban areas versus schools in rural areas. The Cash and Hines studies showed that even though there was positive relationship between school building condition and student achievement both small rural schools and large urban/suburban schools, the amount of difference in student achievement was not the same. It would be beneficial to study the question of school location and students achievement at middle school level.
2. A study could be done on student achievement and school building design. When the middle school concept began, many elementary and high schools were converted to middle schools. The buildings did not fit the design of an ideal

middle school where there would be a separate wing for each grade and there would be very little, if any, interaction between students from different grade levels. Since the middle school concept began there have been many schools built to fit this middle model. A study could be done using school designed as middle schools and those middle schools be housed in converted high schools and elementary buildings to determine if there is a difference in student achievement. It would be interesting to see if student achievement in these schools designed to fit this middle school model made a different in student achievement.

3. A study could be done regionally or nationally at the middle school level comparing the results of studies in other state of the relationship of school building condition and student achievement to see if the results are the similar. It would be interesting to compare the results of state studies in a particular region of the country to see if the same issues exist and how it is being addressed.
4. An in-depth study could be done addressing the relationship of school building condition and its effect on different genders and different nationalities/races. This study showed that males and females were effected differently by the condition of the school building. This should be studied in more detail to see if minority males are affected more or less than non-minority males and the same study for females.

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Appendix A

Summary of the Values of CAPE Responses

Questions	Possible Responses	Values	Lowest Score	Highest Score
2	A	1	1	3
	B	2		
	C	3		
3	A	1	1	3
	B	2		
	C	3		
4	A	1	1	3
	B	2		
	C	3		
5	A	1	1	3
	B	2		
	C	3		
6	A	1	1	3
	B	2		
	C	3		
7	A	1	1	3
	B	2		
	C	3		
8	A	1	1	3
	B	2		
	C	3		
9	A	1	1	3
	B	2		
	C	3		
10	A	1	1	3
	B	2		
	C	3		
11	A	1	1	3
	B	2		
	C	3		

Appendix A (continued)

Summary of the Values of CAPE responses

Questions	Possible Responses	Values	Lowest Score	Highest Score
12	No	0	0	10
	Yes	1		
13	A	1	1	3
	B	2		
	C	3		
14	A	1	1	3
	B	2		
	C	3		
15	No	2	8	16
	Yes	1		
16	A	1	1	3
	B	2		
	C	3		
17	A	1	1	3
	B	2		
	C	3		
18	A	1	1	3
	B	2		
	C	3		
19	A	1	1	3
	B	2		
	C	3		
20	A	1	1	3
	B	2		
	C	3		
21	A	1	1	3
	B	2		
	C	3		

Appendix A (continued)

Summary of the Values of CAPE responses

Questions	Possible Responses	Values	Lowest Score	Highest Score
22	A	1	1	3
	B	2		
	C	3		
23	A	1	1	3
	B	2		
	C	3		
24	A	1	1	3
	B	2		
	C	3		
25	A	1	1	3
	B	2		
	C	3		
26	No	1	1	2
	Yes	2		
27	No	1	1	2
	Yes	2		
28	No	1	1	2
	Yes	2		
29	No	1	1	2
	Yes	2		
30	A	1	1	3
	B	2		
	C	3		

Appendix B
Overall Building Condition Scores and Building Categories

School Number	Overall CAPE Score	Category	School Number	Overall CAPE Score	Category
1	49	Substandard	29	61	Substandard
2	51	Substandard	30	62	
3	52	Substandard	31	62	
4	53	Substandard	32	62	
5	54	Substandard	33	62	
6	54	Substandard	34	63	
7	54	Substandard	35	63	
8	54	Substandard	36	63	
9	55	Substandard	37	63	
10	56	Substandard	38	63	
11	57	Substandard	39	64	
12	57	Substandard	40	64	
13	57	Substandard	41	64	
14	57	Substandard	42	64	
15	58	Substandard	43	64	
16	58	Substandard	44	65	
17	58	Substandard	45	65	
18	58	Substandard	46	65	
19	59	Substandard	47	65	
20	59	Substandard	48	65	
21	59	Substandard	49	65	
22	59	Substandard	50	65	
23	60	Substandard	51	65	
24	60	Substandard	52	66	
25	60	Substandard	53	66	
26	61	Substandard	54	66	
27	61	Substandard	55	66	
28	61	Substandard	56	68	

Appendix B (continued)
Overall Building Condition Scores and Building Categories

School Number	Overall CAPE Score	Category	School Number	Overall CAPE Score	Category
57	68		85	72	Standard
58	68		86	72	Standard
59	68		87	72	Standard
60	68		88	72	Standard
61	68		89	72	Standard
62	69		90	72	Standard
63	69		91	73	Standard
64	69		92	73	Standard
65	70		93	73	Standard
66	70		94	73	Standard
67	70		95	74	Standard
68	70		96	74	Standard
69	70		97	75	Standard
70	70		98	75	Standard
71	70		99	76	Standard
72	70		100	76	Standard
73	70		101	76	Standard
74	70		102	77	Standard
75	70		103	77	Standard
76	70		104	77	Standard
77	70		105	77	Standard
78	71		106	77	Standard
79	71		107	78	Standard
80	71		108	78	Standard
81	71		109	78	Standard
82	71		110	78	Standard
83	71		111	78	Standard
84	71				

Appendix C

Structural Building Condition Scores and Building Categories

School Number	Structural CAPE Score	Category	School Number	Structural CAPE Score	Category
1	18	Substandard	29	25	Substandard
2	20	Substandard	30	26	
3	20	Substandard	31	26	
4	20	Substandard	32	26	
5	20	Substandard	33	26	
6	21	Substandard	34	26	
7	22	Substandard	35	26	
8	22	Substandard	36	26	
9	22	Substandard	37	26	
10	23	Substandard	38	27	
11	23	Substandard	39	27	
12	23	Substandard	40	27	
13	23	Substandard	41	27	
14	24	Substandard	42	28	
15	24	Substandard	43	28	
16	24	Substandard	44	28	
17	24	Substandard	45	28	
18	24	Substandard	46	28	
19	24	Substandard	47	28	
20	24	Substandard	48	28	
21	24	Substandard	49	28	
22	24	Substandard	50	28	
23	24	Substandard	51	28	
24	24	Substandard	52	28	
25	24	Substandard	53	28	
26	24	Substandard	54	28	
27	24	Substandard	55	28	
28	24	Substandard	56	29	

Appendix C (continued).
Structural Building Condition Scores and Building Categories

School Number	Structural CAPE Score	Category	School Number	Structural CAPE Score	Category
57	25		85	31	Standard
58	29		86	32	Standard
59	29		87	32	Standard
60	29		88	32	Standard
61	29		89	32	Standard
62	29		90	32	Standard
36	29		91	32	Standard
46	29		92	33	Standard
56	29		93	33	Standard
66	29		94	33	Standard
67	29		95	33	Standard
68	29		96	33	Standard
69	29		97	33	Standard
70	29		98	33	Standard
71	30		99	33	Standard
72	30		100	34	Standard
73	30		101	34	Standard
74	30		102	34	Standard
75	30		103	34	Standard
76	30		104	34	Standard
77	30		105	35	Standard
78	30		106	35	Standard
79	30		107	35	Standard
80	30		108	35	Standard
81	31	Standard	109	35	Standard
82	31	Standard	110	35	Standard
83	31	Standard	111	35	Standard
84	31	Standard			

Appendix D
Cosmetic Building Condition Scores and Building Categories

School Number	Cosmetic CAPE Score	Category	School Number	Cosmetic CAPE Score	Category
1	37	Substandard	29	46	
2	37	Substandard	30	46	
3	39	Substandard	31	46	
4	39	Substandard	32	46	
5	40	Substandard	33	46	
6	40	Substandard	34	46	
7	40	Substandard	35	47	
8	41	Substandard	36	47	
9	42	Substandard	37	47	
10	42	Substandard	38	47	
11	42	Substandard	39	47	
12	42	Substandard	40	48	
13	42	Substandard	41	48	
14	43	Substandard	42	48	
15	43	Substandard	43	48	
16	43	Substandard	44	48	
17	44	Substandard	45	48	
18	44	Substandard	46	48	
19	44	Substandard	47	48	
20	44	Substandard	48	48	
21	44	Substandard	49	48	
22	44	Substandard	50	48	
23	45	Substandard	51	49	
24	45	Substandard	52	49	
25	45	Substandard	53	49	
26	45	Substandard	54	49	
27	45	Substandard	55	49	
28	45	Substandard	56	49	

Appendix D (continued).
Cosmetic Building Condition Scores and Building Categories

School Number	Cosmetic CAPE Score	Category	School Number	Cosmetic CAPE Score	Category
57	49		85	53	Standard
58	49		86	53	Standard
59	49		87	53	Standard
60	49		88	53	Standard
61	50		89	53	Standard
62	50		90	54	Standard
63	50		91	54	Standard
64	50		92	54	Standard
65	50		93	54	Standard
66	50		94	54	Standard
67	50		95	54	Standard
68	50		96	54	Standard
69	50		97	54	Standard
70	51		98	54	Standard
71	51		99	55	Standard
72	51		100	55	Standard
73	51		101	55	Standard
74	51		102	55	Standard
75	51		103	55	Standard
76	52		104	55	Standard
77	52		105	55	Standard
78	52		106	55	Standard
79	52		107	55	Standard
80	52		108	55	Standard
81	52		109	57	Standard
82	52		110	59	Standard
83	52		111	60	Standard
84	52				

Appendix E

Synthesis of Research on School Building Condition and Student Achievement

Author	Date	Factors relating to school building and student achievement	Type of study data source	Findings
Branham, D.	2002	School Infrastructure	Research Study	This study found that school infrastructure has a critical impact on student achievement. A superb school building with up-to-date facilities brings an atmosphere of high student achievement.
Cash, C.	1993	School Building Condition	Dissertation	The condition of the school facility has a positive impact on Student achievement at the high school level in the Commonwealth of Virginia.
Crampton, F., Thompson, D. and Vesely, R.	2004	Funding for school infrastructure	Professional Article	With the critical role the physical environment of schools have in student success, adequate and equitable funding of nfrastructure takes on a new urgency. In today's environment of high -stakes testing, educators must make use of every tool, including capital dollars to enhance student achievement.

Appendix E (continued).

Synthesis of Research on School Building Condition and Student Achievement

Author	Date	Factors relating to school building and student achievement	Type of study data source	Findings
Crook, J.	2006	School building condition	Dissertation	The condition of the school facility has a positive impact on student achievement at the high school level in the Commonwealth of Virginia.
Earthman, G.	1998	Educational facilities student achievement, student behavior	Professional presentation	The data presented in this paper leads one to the knowledge that the condition of the school building has an influence on student performance.
Earthman, G.	2002	School facilities condition	Research report	The conclusion of this study is that school facility conditions has an influence on student academic achievement. Students who attend school in substandard buildings are handicapped in their academic achievement.

Appendix E (continued).

Synthesis of Research on School Building Condition and Student Achievement

Author	Date	Factors relating to school building and student achievement	Type of study data source	Findings
Earthman, G & Lemasters, L.	1996	Building environment	Research review	All of the studies in this research review revealed a relationship between student performance, both achievement and behavior, and the condition of the building.
Gertel, S., McCarty, P., & Schoff, L.	2004	The optimum acoustical learning environment	Research study	The optimum learning area is critically based on auditory-verbal responses. Classroom noise not only interfere with the student's ability to hear the teacher, but it contributes to students feeling powerless over the classroom environment and gives up on trying to learn.
Hines, E.	1996	School building condition	Dissertation	The condition of the school facility has a positive impact on student achievement at the high school level in the Commonwealth of Virginia.

Appendix E (continued).

Synthesis of Research on School Building Condition and Student Achievement

Author	Date	Factors relating to school building and student achievement	Type of study data source	Findings
Lackney, J.	1999	Condition of physical environment on the education process	Professional presentation	Develop a process in all school districts to determine the environmental qualities that contribute to achievement and improve those qualities.
Lair, S.	2003	School building condition	Dissertation	The condition of the school facility has a positive impact on student achievement in the State of Texas.
Lanham, J.	1999	School building condition	Dissertation	This study found that a positive relationship exist between school building and student achievement at elementary schools in the Commonwealth of Virginia.
Lemasters, L.	1997	Research review	Dissertation	This study reviewed several studies. The conclusion, after reviewing and comparing the studies and several individual components, was that building does have an impact student achievement.

Appendix E (continued).

Synthesis of Research on School Building Condition and Student Achievement

Author	Date	Factors relating to school building and student achievement	Type of study data source	Findings
Lewis, M.	2001	Building condition and student test scores	Dissertation	Facility condition was found to be a stronger predictor of academic achievement than many family background factors and socioeconomic conditions.
Lyons, J.	2001	School building condition and student achievement	Review and analysis of research	The research shows that older buildings may pose a variety of negative consequences for the learning process, while safe and modern schools with controlled environments enhance learning.
Moore, D., and Warner, E.	1998	Upgraded facilities and student achievement	Research study	In this study an analysis of math and science scores of third and sixth grade students for an 11-12 year period surrounding school renovations was done. The findings revealed a correlation between newer facilities and student performance levels.

Appendix E (continued).

Synthesis of Research on School Building Condition and Student Achievement

Author	Date	Factors relating to school building and student achievement	Type of study data source	Findings
O'Neill, D.	2000	School Building	Research study	The data gathered in this study indicated that a positive relationship between building condition and achievement of students exist. Student achievement was higher in newer buildings. The physical structure and condition of a building has the potential to inspire the nature, quality, and direction of what goes on inside.

Appendix F

Date

Dear

A am currently doing research in cooperation with the Division of Educational Leadership and Policy Studies at Virginia Polytechnic and State University. My research involves a study of the relationship between the condition of the school facility and the performance of students on the Virginia Standards of Learning Examination for middle school students in the Commonwealth of Virginia.

The purpose of this study is to determine if there is a relationship among these variables. With the role that the Standards of Learning Examinations play in school accreditation at the state level and the Adequately Yearly Progress component of No Child Left Behind, it is important that we identify any barrier that may be preventing students from performing at their highest level. As the average age of schools hover around 40 years old, it is imperative that we conduct this research to determine if there is a relationship between the condition of educational facilities and student performance on the Standards of Learning Examinations.

In order to complete this research, data on the building condition will be needed. The current condition of school facilities will be determined by the information provided by your Middle School Principals through completion of the Commonwealth Assessment of Physical Environment facilities assessment instrument. The survey consists of 32 questions and should take approximately 15 – 20 minutes to complete.

The names of the participating schools will not be identified in this study, however they will be listed in the appendix. The intent of the report is not to compare schools, but to look at the targeted relationship.

To grant permission for this study to be conducted in your school division, simply reply: “Permission Granted” or “Yes” to this email. Your cooperation is greatly appreciated.

If you have any questions or require clarification, please call me at Windsor Middle School at 757-242-3229 or on my cell at 757-620-9555.

Sincerely,

Calvin Bullock
Candidate for Doctoral Degree
Virginia Polytechnic and State University

Glen I. Earthman
Professor Emeritus
Virginia Tech.

Appendix G

Date

Dear

My name is Calvin Bullock. I am currently doing research in cooperation with the Division of Educational Leadership and Policy Studies at Virginia Polytechnic and State University. My research involves a study of the relationship between the condition of the school facility and the performance of students on the Virginia Standards of Learning Examination for middle school students in the Commonwealth of Virginia.

The purpose of this study is to determine if there is a relationship among these variables. With the role that the Standards of Learning Examinations play in school accreditation at the state level and the Adequately Yearly Progress component of No Child Left Behind, it is important that we identify any barrier that may be preventing students from performing at their highest level. As the average age of schools hover around 40 years old, it is imperative that we conduct this research to determine if there is a relationship between the condition of educational facilities and student performance on the Standards of Learning Examinations.

In order to complete this research, data on the building condition will be needed. The current condition of school facilities will be determined by the information provided by you through your completion of the Commonwealth Assessment of Physical Environment facilities assessment instrument. The survey consists of 32 questions and should take approximately 15 – 20 minutes to complete.

The names of the participating schools will not be identified in this study, however they will be listed in the appendix. The intent of the report is not to compare schools, but to look at the targeted relationship.

To access the assessment instrument, click on the following web link: http://www.surveymonkey.com/Users/83148542/Surveys/638012450339/845B19F2-FAC1-4314-898E. Upon completion, simply click submit and the results will be automatically tallied. Thank you in advance.

If you have any questions or require clarification, please call me at Windsor Middle School at 757-242-3229 or on my cell at 757-620-9555.

Sincerely,

Calvin Bullock
Candidate for Doctoral Degree
Virginia Polytechnic and State University

Glen I. Earthman
Professor Emeritus
Virginia Tech.

Appendix H

Date

Dear

My name is Calvin Bullock. I am the principal of Windsor Middle School in Windsor, VA.

I am conducting a research project in cooperation with the Division of Educational Leadership and Policy Studies at Virginia Polytechnic and State University (Virginia Tech). My research involves a study of the relationship between the condition of the school building and the performance of eighth (8^{th}) students in the Commonwealth of Virginia on the Virginia Standards of Learning Examination.

The purpose of this study is to determine if there is a relationship among these variables. With the role that the Standards of Learning Examinations play in school accreditation, it is important that we identify any barriers that may be preventing students from performing at their highest level. As the average age of schools hover around 40 years old, it is imperative that we conduct this research to determine if there is a relationship between the condition of educational facilities and student performance on the Standards of Learning Examinations.

In order to complete this research, data on the building condition will be needed. The current condition of school facilities will be determined by the information provided by you through your completion of the Commonwealth Assessment of Physical Environment (CAPE) facilities assessment instrument. **The survey consists of 33 questions and should take approximately 15 minutes to complete.**

The names of the participating schools will not be identified in this study.

I have attached a copy of the CAPE assessment for your school. Please take a few minutes to complete it and return it to me in the self addressed stamped envelope.

If you have any questions or require clarification, please call me at Windsor Middle School at 757-242-3229 or on my cell at 757-620-9555. Thank you in advance for your time and cooperation.

Sincerely,

Calvin Bullock Candidate for Doctoral Degree Virginia Tech.	Glen I. Earthman Professor Emeritus Virginia Tech.

Appendix I

Commonwealth Assessment of Physical Environment

Introduction

Thank you for agreeing to complete the CAPE assessment instrument to rate your school. Please feel free to make any comments in the space provided to clarify or express your concern.

1. Please complete the following information.
   School Name:
   School Division:
   Principal's Name:

2. What is the age of the school building in number of years? A facilities age is your best estimate of the time period during which most of the space used by students was built.
   - ☐ a. 40-60 years old or older
   - ☐ b. 20-39 years old
   - ☐ c. 0-19 years old

3. Are windows visible in each instructional area?
   - ☐ a. Windows are fewer that 1/4th of the instructional spaces
   - ☐ b. Windows are in at least 1/4th, but fewer than 3/4ths of the instructional spaces
   - ☐ c. Windows are in at least 3/4ths of the instructional spaces

4. What kind of flooring is found in the majority of the instructional areas?
   - ☐ a. Wood floor
   - ☐ b. Tile or terrazzo
   - ☐ c. Carpet

5. What quality of heat is found in the majority of the instructional spaces?
   - ☐ a. Uneven heat/unable to control in each room
   - ☐ b. Even heat/unable to control in each room
   - ☐ c. Even heat/able to control in each room

6. What quality of air conditioning system is found in the majority of the instructional spaces?
   - ☐ a. No air conditioning available
   - ☐ b. Air conditioning in some instructional spaces, or air conditioning in all instructional spaces, but not well regulated
   - ☐ c. Air conditioning in all instructional spaces which can be well regulated

7. When was the last time the interior walls, including classroom spaces, were painted?
- ☐ a. Over 15 years ago
- ☐ b. Between 8 and 15 years
- ☐ c. Less than 8 years ago

8. Is there a regularly scheduled painting cycle for interior walls? Is so, what is it?
- ☐ a. No
- ☐ b. Yes, over 8 year cycle
- ☐ c. Yes, 8 year or fewer year cycle

9. When was the last time the exterior walls or windows and trim, were painted?
- ☐ a. Over 7 years ago
- ☐ b. Between 4 and 7 years
- ☐ c. Within the last 4 years or no exterior surface requires exterior surface painting

10. Is there a regularly scheduled painting cycle for exterior walls, or windows & trim? If so, what is it?
- ☐ a. No
- ☐ b. Yes; Over 7 year cycle
- ☐ c. Yes; 7 year or fewer year cycle or not needed because no exterior surface requires periodic painting

11. Are there indications of roof leaks in the building?
- ☐ a. Ceiling is deteriorating due to water damage, and / or water falls in some areas of the facility requiring buckets for water collection
- ☐ b. Ceiling is currently developing a few stains due to minor leaks
- ☐ c. No visible signs, or only a few old water spots in ceiling

12. Which of the following facilities are adjacent to, or part of, the school complex? Please check all that apply.
- ☐ a. Football stadium
- ☐ b. Football field
- ☐ c. Soccer field
- ☐ d. Tennis courts
  - ☐ i. 1-2
  - ☐ ii. 3-5
  - ☐ iii. Over 5
- ☐ e. Swimming pool
- ☐ f. Softball field
- ☐ g. Wrestling room
- ☐ h. Weight room

13. How often are classroom floors swept (if wood, tile or terrazzo) or vacuumed (if carpeted)?

☐ a. Monthly
☐ b. Weekly
☐ c. Daily or more frequently

14. How often are classroom floors mopped (if wood, tile or terrazzo) or cleaned (if carpeted)?

☐ a. Annually
☐ b. Monthly
☐ c. Daily or weekly

15. Is graffiti commonly found on premises?

a. Bathrooms	☐Yes	☐No
b. Lockers	☐Yes	☐No
c. Hallways	☐Yes	☐No
d. Classroom walls/doors	☐Yes	☐No
e. Other interior areas	☐Yes	☐No
Please Specify:		
f. Exterior walls	☐Yes	☐No
g. Exterior walkways	☐Yes	☐No
h. other exterior surfaces	☐Yes	☐No
Please Specify:		

16. How long does the graffiti remain before it is removed?

☐ a. Until summer maintenance
☐ b. More than a week, less than a month
☐ c. Less than a week or no to all parts of #14

17. What is the condition of the lockers?

☐ a. Most are not functional or not in good repair
☐ b. At least three-fourths of the lockers are functional and in good repair
☐ c. Over three-fourths of the lockers are functional and in good repair

18. What type of material is used for the majority of interior classroom ceilings?

☐ a. Wood or open beams
☐ b. Plaster or acoustical tiles in at least three/fourths of the instructional spaces
☐ c. Acoustical tiles throughout the instructional spaces

19. Please indicate which utilities or equipment are available and in usable condition in the science labs?
- ☐ a. Sinks & Water
- ☐ b. Sinks, Water & Electricity
- ☐ c. Sinks, Water, Electricity, & Gas

20. How long ago was science equipment updated to current standards?
- ☐ a. Over 10 years ago
- ☐ b. Between 5 and 9 years ago
- ☐ c. Less than 5 years ago or the building is less than 5 years old

21. What type of lighting is available in the instructional areas?
- ☐ a. Incandescent lighting
- ☐ b. Fluorescent lighting– hot
- ☐ c. Fluorescent lighting– cold

22. What is the condition of the classroom furniture?
- ☐ a. Most rooms have furniture that is either facially scarred or functionally damaged
- ☐ b. Though at least half the rooms may have some minor facial scars on the student desks, all the furniture is functionally sound and looks satisfactory
- ☐ c. All the classrooms have furniture which is functionally sound and facially attractive

23. What is the condition of the school grounds?
- ☐ a. There is no landscaping, and sidewalks are either not present or damaged
- ☐ b. There is landscaping and the sidewalks are present and in good repair (acceptable to the community)
- ☐ c. The landscaping and other facilities are attractive and well maintained (it is a center of pride for the community

24. What color are the walls in a majority of the instructional spaces?
- ☐ a. Dark colors
- ☐ b. Pastel colors
- ☐ c. White or off-white colors

25. Is the facility located near a busy, major high-way, frequently used rail line, an area where aircraft frequently pass overhead, or any other loud noise producing environment?

☐ a. Yes, and no measures have been taken to reduce the noise level within the facility
☐ b. Yes, but measures have been taken to reduce the level of noise within the facility
☐ c. No

26. Do classrooms have connections to a school-wide local area computer network?

☐ No
☐ Yes

27. Do classrooms have connections to a district-wide or other wide area computer network?

☐ No
☐ Yes

28. Do classrooms have internet access?

☐ No
☐ Yes

29. Do classrooms have cable connections to a central television antenna or other cable television system?

☐ No
☐ Yes

30. What do you consider the condition of your facility cosmetically and structurally?

☐ a. Below standard
☐ b. Standard
☐ c. Above Standard

31. What is the approximate gross square footage of the facility? (Use buildings' rough dimensions)

32. What is the approximate acreage of the school site?

33. Please include any additional comments you would like to make about your building in the space below.

VITA

Calvin C. Bullock
6401 Olde Bullocks Circle
Suffolk, Virginia 24535
Home: (757) 483-5985
Office: (757) 242-3229

Education	Defense of Doctoral Dissertation, Summer 2007 Virginia Polytechnic Institute and State University Blacksburg, Virginia
	Master of Science, 1995 Education Old Dominion University Norfolk, Virginia
	Master of Public Administration, 1993 Troy State University Troy, Alabama
	Bachelor of Science, 1986 Education Southern Illinois University Carbondale, Illinois
Employment	Principal Windsor Middle School Isle of Wight County Public Schools Smithfield, Virginia
	Assistant Principal Smithfield Middle School Isle of Wight County Public Schools Smithfield, Virginia
	Teacher Smithfield Middle School Isle of Wight County Public Schools Smithfield, Virginia

Close Window

July 2005

Building Better Schools

High-performance schools are retaining teachers, improving test scores, and bringing communities together

Facilities are rarely discussed when the quality of education is called into question. However, the physical environment can *significantly* impact students' learning and instructors' teaching capabilities. With a rising number of studies validating this, a new philosophy of school design and operation has been born. The high-performance school seeks to solve many of the ills associated with inadequate school building conditions and resulting problems with poor student performance, faculty retention, and excessive operating costs.

With the general public begging for tax cuts, the ability for school districts to secure funding and voter approval on bond issues has become increasingly difficult. As a result, budgets for new school buildings and necessary maintenance and repairs have shrunk, resulting in the proliferation of overcrowded facilities that are costly to operate, inhibit learning, and are sometimes unhealthy for staff and young students.

The most recent statistical analysis completed by the U.S. Department of Education, *Condition of America's Public School Facilities: 1999,* reports that $127 billion is needed for repairs, renovations, and modernizations in order for U.S. schools to be in good overall condition. While this estimate is sizable, some organizations report less conservative projections. As stated in the American Society of Civil Engineers' *2005 Infrastructure Report Card,* "The National Education Association (NEA) reported in 2000 that the need was even greater, more than $268 billion." These numbers are now 5 years old; imagine the need today.

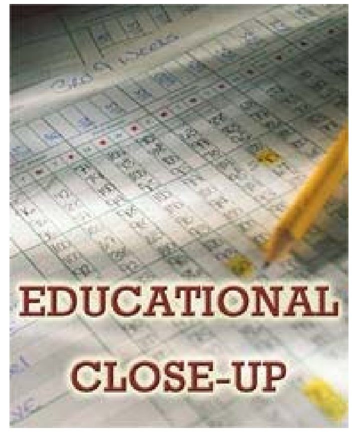
Rising enrollments, combined with the mandates of the *No Child Left Behind Act,* are exacerbating the situation. A report published by the 21st Century School Fund, titled *For Generations to Come: A Leadership Guide to Renewing Public School Buildings,* identifies the following impacts of inadequate schools:

- Alienated students.
- Low staff morale.
- High rates of teacher attrition.
- Inability to provide specialized curricula.
- Reduced learning time.
- Distractions from learning.
- Reduced ability to meet special needs.
- Lack of technological proficiency.
- Health problems for staff and students.
- Safety hazards.
- Less supervision of students' behavior.

Ushering in hope and guidance for better school buildings, organizations and associations have rallied together to define what the next generation of school buildings can offer. High-performance schools seek to decrease or eliminate the negative side effects associated with inadequate learning environments. They not only remove obstacles to learning and teaching, but provide a comfortable environment in which students can excel, teachers can explore new methods and approaches, and the community can congregate.

The Benefits of High-Performance Schools

Students learn. Better environments result in greater learning potential. It may sound obvious, but quantifying the impact of school building conditions on student productivity and performance has been the subject of numerous studies. The results are overwhelming: Higher test scores result when students are taught in an environment that provides appropriate lighting and/or daylighting, is not plagued by poor indoor air quality, provides comfortable thermal conditions, and is free of excessive noise. "If the kids can hear, see, not be sick, and are comfortable - thermally, visually, and acoustically - they're going to perform better," says Charles Eley, executive director, Collaborative for High Performance Schools (CHPS), San



Resources

2005 Infrastructure Report Card, American Society of Civil Engineers

Building Healthy, High Performance Schools: A Review of Selected State and Local Initiatives, Environmental Law Institute

Classroom Acoustics: A Resource for Creating Learning Environments with Desirable Listening Conditions, Acoustical Society of America

Condition of America's Public School Facilities: 1999, U.S. Department of Education, National Center for Education Statistics

Do School Facilities Affect Academic Outcomes? Mark Schneider, professor of political science, State University of New York, Stony Brook

For Generations to Come: A Leadership Guide to Renewing Public School Buildings, 21st Century School Fund

High-Performance School Building Resource and Strategy Guide, 2nd edition, Sustainable Buildings Industry Council

Windows and Classrooms: A Study of Student Performance and the Indoor Environment - CEC PIER 2003, Heschong Mahone Group Inc.

school due to illness. They can learn in an environment that is both healthy and safe.

Faculty benefits. Teachers reap the rewards of high-performance schools for the same reasons. “New schools that are opening and embody a lot of these characteristics seem to have a much higher retention rate for teachers and waiting lists - not just because they’re new,” says Deane Evans, executive director at New Jersey Institute of Technology’s Center for Architecture and Building Science Research, and author of the Sustainable Buildings Industry Council’s *High-Performance School Buildings Resource and Strategy Guide.* The ability of the school to become a teaching tool allows instructors to expand curricula. Jim Jones, director for the Center for High Performance Learning Environments, and associate professor at Virginia Tech’s College of Architecture and Urban Studies, Blacksburg, VA, explains: “For example, the integration of energy systems such as thermal solar heating or photovoltaics not only can reduce the use of purchased energy, but could be used as experiments for science classes.”

Environmental impact is minimized. Because high-performance schools strive to reduce the building’s impact on the environment, resources are conserved. With the implementation of energy-efficient technologies and systems, less energy is consumed, reducing greenhouse gas emitted by power plants. While it may seem like the goals for high-performance schools and green building initiatives are the same, the philosophies differ. “Green design solutions *can* result in better learning environments,” says Jones. “However, high performance should go beyond green to consider the interactions and relationships between students, teachers, [the] building, and technology.” In other words, while many high-performance schools are green buildings, not all green schools can be considered high-performance schools.

Owners and operators save. It goes without saying that the more efficient a building is, the less it costs to operate. This makes high-performance schools not only highly cost-effective, but also a dream come true for taxpayers. Additionally, with so much emphasis placed on providing the optimum environment for learning, the owner’s exposure to liability is reduced.

Communities gather. High-performance schools serve as the ideal location for neighborhood meetings, gatherings, and events. They can bring together groups of people for numerous functions. This is important because it integrates the school into the community and, conversely, involves the community with the school. The building becomes more than a school - it’s a community center as well.

High-Performance School Benefits	
The Benefit to Students	**Putting it to the test:** Students thrive in buildings that are safe, healthy, and designed for learning. Test scores are proof.
	Don’t despair - incorporate fresh air: Due to improved ventilation and indoor air quality, high-performance schools report less absenteeism, the result of healthier students.
The Benefit to Teachers	**Great working conditions:** Teachers and staff reap the same benefits as students, breathing healthier air and working in more comfortable conditions. The result is increased teacher retention rates.
	Expanded curriculum possibilities: The building itself becomes a teaching tool, providing greater flexibility and real-world application of lessons.
The Benefit to the Environment	**Protecting and preserving natural resources:** High-performance schools consume less water and energy and help reduce greenhouse gas emissions.
The Benefit to the Owner/Operator	**The bottom line looks better:** The efficiency of high-performance schools results in reduced operating costs, a win-win for taxpayers and building owners.
	Controlling liability: Because high-performance schools are healthier, more environmentally friendly buildings, an owner’s exposure to liability is reduced.
The Benefit to the Community	**A community center in disguise:** What’s good for students is also good for the community. High-

	performance schools serve as the ideal place for meetings, gatherings, and events.

High-Performance Schools by Design

These high-performance goals are achieved by using a whole building integrated design strategy. CHPS defines this process in the following way: “From the beginning of the design process, each of the building elements (windows, walls, building materials, air-conditioning, landscaping, etc.) is considered part of an integrated system of interacting components. Choices in one area often affect other building systems; integrated design leverages these interactions to maximize the overall building performance.” While every high-performance school differs from one another, each is designed to optimize IAQ, thermal comfort, lighting and daylighting, and acoustics (among many other factors).

IAQ. What does the energy crisis of the 1970s have to do with poor indoor air quality in America’s schools? Unfortunately, as the push to save energy swept across the nation, more tightly sealed buildings were constructed and ventilation rates were reduced in an effort to cut consumption. Factor in the use of synthetic building materials and furnishings, pesticides, and cleaning supplies and it’s no wonder that faculty and students who are breathing increasing supplies of contaminated air in schools are experiencing more respiratory illnesses. According to Mark Schneider, professor of political science, State University of New York, Stony Brook, in the 2002 report *Do School Facilities Affect Academic Outcomes?* “... enhanced ventilation rates not only deliver more adequate supplies of fresh air, but also help dilute or remove contaminants, especially chemical (e.g. formaldehyde, toluene, and styrene) and biological (e.g. mold and bacteria) contaminants that have highly demonstrable negative health effects.”

“Some kids are pretty tolerant of bad air quality - others are not. And if you look at the incidence of asthma and other breathing-related diseases in schools, they’ve grown significantly in the last few decades,” Eley says. The U.S. Department of Education analysis noted that 26 percent of schools ranked ventilation as the most unsatisfactory environmental condition in their facility(s). The effects that poor indoor air quality can have on students range from mild or severe asthma attacks to drowsiness, headaches, and dizziness - not to mention the school days missed while recuperating at home. According to CHPS, “High-performance schools mitigate poor indoor air quality by using materials that do not off-gas hazardous chemicals, [by] utilizing properly designed ventilation and air-conditioning systems, and [by] focus[ing] on preventative maintenance.”

Thermal comfort. The issue of thermal comfort in schools deserves more than a shrug of the shoulders and a you-can’t-please-everyone attitude. As noted in Schneider’s report, numerous studies prove there is an optimum range for both temperature and humidity at which students are best able to perform tasks and remain healthy. According to the *Academic Outcomes* report, “... students will perform mental tasks best in rooms kept at moderate humidity levels (40 to 70 percent) and moderate temperatures in the range of 68 to 74 degrees F.”

Unfortunately, many schools (29 percent, according to the U.S. Department of Education) are plagued by inadequate heating, ventilation, and air-conditioning systems. The aim of high-performance schools to provide environments that are not too warm, cold, or humid mandates the use of well-designed ventilation and cooling systems.

Lighting and daylighting. Environments with the right lighting design enhance visual acuity and comfort. Not only is artificial lighting design critical, but many researchers have proven that access to outdoor views and the infiltration of daylight can have a positive effect on pupils. “Students who are in classrooms with more natural daylight have been shown to achieve higher scores on standardized tests, progress faster in math and reading, pay attention longer, and even miss fewer days of school,” reports the 21st Century School Fund in *For Generations to Come.*

The most frequently cited study on the impact of daylight on students was completed by the Fair Oaks, CA-based Heschong Mahone Group Inc. Results from previous studies highlighted in *Windows and Classrooms: A Study of Student Performance and the Indoor Environment* have quantified the value of daylight in classrooms by charting between a 7- and 26-percent improvement in student learning rates. However, the Heschong Mahone Group findings warn against the negative impacts of glare and direct sun penetration, which can be detrimental to student performance, especially with respect to math comprehension. According to Eley, high-performance schools should eliminate direct sunlight penetration; provide gentle, uniform illumination; avoid glare; provide control of electric lights; and be planned with daylighting design principles in mind.

Acoustics. Noise levels can affect learning. After all, if students can’t hear, they can’t learn. However, the problems resulting from poor acoustics can be even more serious. “Noise levels influence verbal interaction, reading comprehension, blood pressure, and cognitive task success, and may induce feelings of helplessness, inability to concentrate, and lack of extended application to learning tasks,” states Schneider in his *Academic Outcomes* report. To ensure that students are able to remain focused, concentrate on tasks, and communicate effectively, high-performance schools must take measures to reduce the excessive noise resulting from building equipment and adjacent spaces. The Melville, NY-based Acoustical Society of America has published information on the basics of classroom acoustics and their impact on student and teacher performance.

Top Design Considerations				
According to the Washington, D.C.-based Sustainable Buildings Industry Council, the numerous building blocks of a high-performance school include: • Acoustical, thermal, and visual comfort.Superior indoor air quality. • Environmentally responsive site planning. • An energy-efficient building shell. • High-performance lighting and HVAC systems. • Daylighting. • Renewable energy. • Environmentally preferable materials and products. • Water efficiency. • Life-cycle cost and energy analysis. • Safety and security • Building commissioning. Of these, the most-studied elements of building design found to impact students are IAQ, thermal comfort, lighting and daylighting, and acoustics.	**IAQ** The effects that poor indoor air quality can have on students range from mild or severe asthma attacks to drowsiness, headaches, and dizziness - not to mention the school days missed while recuperating at home. According to the U.S. Department of Education, children are absent from school due to asthma 6 million days per year in K-12 schools.	**Thermal Comfort** Inadequate heating and cooling can create an unnecessary distraction for students, who may spend more time sweating or shivering than learning. Mark Schneider's Do School Facilities Affect Academic Outcomes? reports that moderate temperatures (between 68 and 74 degrees F.) and moderate humidity levels (40 to 70 percent) allow students to perform mental tasks best.	**Lighting/ Daylighting** A school's design should provide views to the outdoors (when possible), eliminate direct sunlight penetration and glare, as well as provide gentle, uniform illumination. Additionally, daylighting is worth exploring. "Students who are in classrooms with more natural daylight have been shown to achieve higher scores on standardized tests, progress faster in math and reading, pay attention longer, and even miss fewer days of school," reports the 21st Century School Fund in *For Generations to Come.*	**Acoustics** Excess noise can distract students and make speech intelligibility difficult. "In many classrooms in the United States, the speech intelligibility rating is 75 percent or less. That means that, in speech intelligibility tests, listeners with normal hearing can understand only 75 percent of the words read from a list," reports the Acoustical Society of America in its Classroom Acoustics booklet. The ideal conditions for learning are created when acoustics are considered as part of the school's integrated design.

The Price of High-Performance Schools

Designing, constructing, and operating schools that are buildings built for learning is obviously advantageous; so why aren't more people using this strategy for their new construction projects? The reasons vary from lack of information and fear of something new to the assumption that high-performance means higher costs. "You can always build a better school for more money; you can always build a worse school for more money, too," says Evans.

"In my opinion, soft costs add between $1 and $2 per square foot and hard costs are negligible," says Eley. The increased initial expense is due in large part to additional design and commissioning time. To manage the initial costs, define priorities and - when possible - make trade-offs. "The schools that do a pretty good job of improving performance of the facility - particularly with respect to daylighting, energy, and indoor air quality, which are the big three - do it by trading things off and by integrating design," he explains. For example, if it's a priority to have a lavish auditorium on a grand scale, recognize that this may limit (or eliminate altogether) spending on high-performance building features that could improve the condition of classrooms (the spaces where students spend the most time each day).

Because of the integrated design approach, each decision impacts another and often balances costs, which might at first seem steep. For example, the initial investment for exterior lightshelves to enable daylighting without glare means that a classroom can be occupied a certain percentage of the time without the need for artificial lighting. Because of this, the lighting system can be downsized, resulting in lower initial costs and reduced energy consumption over the life of the building. According to CHPS, "High-performance design saves money on both sides of the ledger by reducing operating costs *and* increasing school funding."

When you factor in the ability of high-performance schools to retain teachers, optimize student performance, benefit the community, and maximize resource efficiencies, implementing this strategy is well worth the money. It's time to start recognizing the impact facilities have on education and start building better schools. Our children, teachers, communities, and the environment deserve better.

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Influence of the School Environment on Student and Teacher Attitudes:

Student attitudes are shaped to some extent by the structures (facilities) through which they are mediated (Ferreira, 1995). In fact, building conditions can directly affect the attitudes of students or the attitudes of teachers and parents which in turn affect student attitudes. Proshansky (1970) referred to physical settings and attitudes as follows: Physical settings-simple or complex-evoke complex human responses in the form of feelings, attitudes, values, expectancies, and desires, and it is in this sense as well as their known physical properties that their relationships to human experience and behavior must be understood. (p.28)

There is a body of research in the area of school facilities and their relationship to student and teacher attitudes. Stockard and Mayberry (1992) found that the quality of a physical plant or environment is related to non-cognitive outcomes, such as better attitudes toward school. These outcomes may eventually relate to higher academic achievement. Christopher (1988) concluded that human nature makes people feel better about themselves when their surroundings are pleasant. Students who have better attitudes usually learn more and work harder. McGuffey (1972) conducted a study investigating pupil attitudes toward their school buildings in the elementary level. He found that students housed in newer school buildings which were fully carpeted and air-conditioned showed more positive attitudes than students housed in older buildings.

A study completed by Lovin (1972) in Middle Georgia explored the attitudes of elementary children who had moved from a traditional school to an open-space school. It was shown that the children were keenly aware of their school building and responded positively to bright and comfortable surroundings. In fact, these children's attitudes were directly related to their physical surrounding. Chan (1982) compared student attitudes toward the physical environment of a school opened in 1980 and that of two older schools: one built in 1923 and the other in 1936. The main finding of this study indicated that pupils housed in a modern school building have significantly more positive attitudes toward school than do pupils housed in a much older building. Likewise, Cramer (1976) studied selected Junior High Schools in the Bibb County School District of Georgia. He contended that pupils housed in newly renovated school facilities showed more positive attitudes.

In the area of self-concept, Bowers and Burkett(1989) concluded that self-concept scores on the Piers-Harris Children's Self-Concept Scale of students in a modern facility were significantly higher than the student scores of those housed in an older facility. Maslow and Mintz (1956) studied student attitudes in "ugly, neutral and beautiful" rooms finding significant differences corresponding to room quality in the responses (p.466). These researchers revealed that the mean rating given by the subjects in the beautiful room was in the range defined as "energy" and "well-being" while the mean of the ratings given by subjects in both the average and ugly rooms was in the range defined as "fatigued" and "displeased" (p.466). Furthermore, the students placed in the beautiful room expressed feelings of "comfort, pleasure, enjoyment, importance, energy and a desire to continue their activity" (p.466). Thus, if children have positive attitudes and look forward to attending school, it stands to reason they will do better in their classes (Christopher, 1988).

Teachers' attitudes are also directly related to the school facility. Several studies have been conducted in the area of open-space classrooms and their effect on teacher attitudes. Lewis (1976) examined the influence of open-space classrooms and closed-space classrooms on the attitudes of teachers toward the school building. It was found that teachers housed in open-space classrooms showed more positive attitudes. Likewise, Jones (1974) concluded that teachers' attitudes toward their students in open-space classrooms improved significantly. Mills(1972) agreed with Jones' findings when he concluded that teachers in open-space areas exhibited behaviors that allowed greater pupil freedom and self-direction. These teachers displayed behaviors which were more permissive, supportive, warm and sympathetic toward students. As one can see, not only does the physical environment of a school affect children, teachers are also affected by the design of a school building. And so, school architects, educators and facility planners must take into consideration the impact that the design of school buildings have on student and teacher attitudes.

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National Foundation
for Educational Research

The effects of the school environment on young people's attitudes towards education and learning

Summary Report

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CONTENTS

1. Introduction

1.1 Background

Partnerships for Schools (PfS) is responsible for delivering the government's secondary school renewal programme, Building Schools for the Future (BSF). PfS is working with local authorities and the private sector to rebuild or renew every one of England's 3,500 state secondary schools during the 15-year lifetime of the multi-billion BSF programme. PfS's education and design specialists work with local authorities to develop education visions to create innovative and exciting learning environments for schools.

The first new build school, delivered by a Local Education Partnership, opened in Bristol in September 2007. The National Foundation for Educational Research (NFER) was been commissioned by PfS to assess the impact of the school environment on young people's attitudes towards their education and learning. The research comprised 'before' and 'after' surveys administered to students in year groups 7 and 8 in this first BSF school. Students were surveyed about their thoughts on their school environment, the learning opportunities available to them and their views on their new school.

1.2 Aims of the research

The key research objective of the study was:

> *To demonstrate the difference that BSF schools are making to young people's attitudes towards education and learning, as measured by their levels of engagement and enthusiasm for school.*

This key research objective was further broken down into a number of research questions. These included the following:

- Has the new school environment contributed to students' levels of motivation and engagement?
- Do students think that the new buildings/facilities have created better learning opportunities?
- Has the move from old to new buildings affected students' study skills or their learning behaviours?
- Have students' attitudes to school changed in any notable ways?
- Have students' feelings of self-worth, self-esteem and self-efficacy been affected by the new environment?

- How have the new buildings changed students' ways of learning? How has the use of ICT changed?
- How has the new environment affected teaching and learning? Are there any differences in the ways that teachers teach?
- Do students feel that the new buildings will have any impact on their learning outcomes?

1.3 Methodology

The evaluation consisted of 'before' and 'after' surveys to two year groups of students in the first BSF school. The 'before' survey was administered to Year 7 and 8 students prior to the opening of the new building at the end of the summer term 2007. The 'after' survey was administered to the same year cohorts (now Years 8 and 9), towards the end of the autumn term, hence there was a period of five months between the two surveys. The same questionnaire was used in both surveys in order to enable direct comparison of the student's attitudes over this time period.

A request was made that the survey should be issued to four of the six form groups in each year group and the response rates were very encouraging: the total number of students who responded to the first survey was 193 and 203 students responded to the second survey (approximately 80 and 84 per cent response rates, respectively, from these form groups). In addition, a short proforma was administered to form tutors for year groups 8 and 9, in the autumn term, in order to provide retrospective and current contextual information. Eight tutors (four from each year group) completed questionnaires, and their responses are presented where appropriate throughout the report.

The findings from both 'before' and 'after' surveys are presented in the following sections.

2. Survey findings

2.1 Your school

Students were asked a range of questions, in both surveys, on their feelings about their school. Questions addressed particular issues such as vandalism or bullying, the design of the school buildings, and what students liked the most and the least about their school building.

First, students were asked to give their opinions on a number of statements relating to how they felt when they were at school. The responses are presented in Tables 1a and 1b.

Table 1a - Before Survey

Please give us your opinions on the following statements:

	Yes, all the time %	Yes, most of the time %	No, not really %	No, Never %	No response %
I feel positive when I am at school	12	72	12	2	2
It is easy to learn in my school	8	65	22	3	2
I enjoy going to school	13	37	38	10	2
I feel proud of my school	10	33	44	10	3
I feel confident when I am at school	17	55	20	4	4
I am happy at school	17	59	17	4	3
I feel motivated to do my school work	14	49	28	5	4
I feel safe in my school	16	41	33	7	4
I feel valued by my school	11	40	36	6	7
N = 196					

A series of single response items
Due to rounding, percentages may not always sum to 100
Source: NFER Survey on the effect of the school environment, 2007.

Table 1b - After Survey

Please give us your opinions on the following statements:

	Yes, all the time	Yes, most of the time	No, not really	No, Never	No response
	%	%	%	%	%
I feel positive when I am at school	11	69	14	4	3
It is easy to learn in my school	15	70	12	2	1
I enjoy going to school	14	47	28	10	1
I feel proud of my school	29	48	19	3	2
I feel confident when I am at school	23	58	14	3	2
I am happy at school	23	57	15	5	1
I feel motivated to do my school work	12	56	25	3	3
I feel safe in my school	34	53	9	3	2
I feel valued by my school	20	46	25	4	4
N = 203					

A series of single response items
Due to rounding, percentages may not always sum to 100
Source: NFER Survey on the effect of the school environment, 2007.

In the ‘before’ survey, while a majority of students responded positively to most of the statements, only half of the students said that they enjoyed going to school and less than half said that they felt proud of their school.

In the ‘after’ survey, a higher proportion of students responded positively to nearly all the statements. The greatest improvements in attitudes between the two surveys were in the feelings of safety and pride: for example, the proportion of students who said that they felt safe at school most or all of the time increased from 57 per cent to 87 per cent, and the proportion who said that they felt proud of their school increased from 43 per cent to 77 per cent. There were also noticeable increases in the proportions of students who said in the ‘after’ survey that they enjoyed going to school, felt valued, and found it easy to learn in school.

In the teacher survey, the majority of respondents said that they enjoyed teaching more and felt more motivated and proud to be a teacher at the school following the opening of the new buildings. All eight respondents felt more able to say, with the new buildings, that the school provided an excellent teaching and learning environment.

The questionnaires then listed a number of potential issues, and respondents were asked how far they felt that these were a problem in their school. The students' responses are presented in Tables 2a and 2b.

Table 2a – Before Survey

Do you think any of the following are problems in your school?

	No, not a problem at all %	A bit of a problem %	Yes, a big Problem %	No response %
Vandalism	10	42	42	6
Graffiti	14	50	32	5
Litter	5	28	63	5
Bullying	11	46	39	4
Smoking	10	44	42	4
Other	4	7	16	74
N = 196				

A series of single response items
Due to rounding, percentages may not always sum to 100
Source: NFER Survey on the effect of the school environment, 2007.

Table 2b – After Survey

Do you think any of the following are problems in your school?

	No, not a problem at all %	A bit of a problem %	Yes, a big Problem %	No response %
Vandalism	66	30	3	3
Graffiti	78	15	4	3
Litter	30	59	8	3
Bullying	27	55	16	3
Smoking	36	34	28	2
Other	2	7	5	86
N = 203				

A series of single response items
Due to rounding, percentages may not always sum to 100
Source: NFER Survey on the effect of the school environment, 2007.

The responses to this question indicate that all of the issues were felt to be less of a problem after the opening of the new school buildings. The most noticeable differences concerned vandalism and graffiti which were perceived to be at least ‘a bit of a problem’ by over 80 per cent of respondents in the ‘before’ survey, but by only 33 per cent and 19 per cent respectively in the ‘after’ survey. Over 60 per cent of respondents in the ‘before’ survey said that litter was a big problem, whereas less than 10 per cent did so in the ‘after’ survey. Bullying and smoking, which were felt to be a big problem by about 40 per cent of students in the ‘before’ survey, were identified as such by only 16 per cent and 28 per cent respectively of students in the ‘after’ survey.

Nearly all the respondents to the teacher survey thought that vandalism, graffiti, litter and smoking were less of a problem with the new school buildings. Bullying, however, was felt to be less of a problem by only three respondents, with the remaining five thinking it was about the same as before.

Moving into a new building has clearly improved perceptions regarding the impact of these problems, but of course it remains to be seen how these perceptions develop as more use is made of the buildings and these become less ‘new’.

Both student and teacher surveys included a question relating to the design of the school buildings. The students’ responses are presented in Tables 3a and 3b.

Table 3a – Before Survey

How would you describe the design of your school buildings?

	Yes %	No %	Not sure %	No response %
Inspirational	16	58	23	3
Boring	60	25	11	4
Comfortable	28	49	18	5
Stimulating	17	45	30	8
Colourful	20	65	10	5
Relaxed	25	56	15	5
Motivational	18	46	31	5
Overwhelming	18	52	25	6
Exciting	21	64	9	6
Scary	21	57	17	5
N = 196				

A series of single response items
Due to rounding, percentages may not always sum to 100
Source: NFER Survey on the effect of the school environment, 2007.

Table 3b – After Survey

How would you describe the design of your new school buildings?

	Yes %	No %	Not sure %	No response %
Inspirational	55	19	22	5
Boring	23	58	14	5
Comfortable	61	22	13	4
Stimulating	37	26	29	9
Colourful	77	14	5	4
Relaxed	57	27	12	4
Motivational	42	26	23	9
Overwhelming	32	39	21	8
Exciting	47	33	17	3
Scary	3	82	9	5
N = 203				

A series of single response items
Due to rounding, percentages may not always sum to 100
Source: NFER Survey on the effect of the school environment, 2007.

As compared with the ‘before’ survey, the ‘after’ survey showed large increases in the proportions of students who felt that their school buildings were inspirational, colourful, motivational, stimulating, relaxed and comfortable. At the same time, there was a reduction in the proportion of students who felt the buildings were boring or scary.

Respondents to the teacher survey were almost unanimous in thinking that the new buildings were more inspirational, stimulating, motivational, exciting, colourful and comfortable than the old school buildings. There was, however, a spread of views as to whether they were more ‘relaxed’.

2.2 Spaces and places in your school

Students were asked a range of questions about places and areas within their school environment. Areas included: where students felt they learned best in their school; where they most enjoyed learning; and whether there were places in the school in which they could do certain activities such as meet with their friends.

In another question in the survey, students were asked about the places in their school in which they felt they could learn best. The question provided a list of possible response options and students were asked to tick all that applied. The responses are presented in Tables 4a and 4b.

Table 4a – Before Survey

Where do you learn best in your school?

	%
Classrooms	60
Learning resource centre/Library	39
Areas where there is a range of ICT	67
Sports hall	46
Practical spaces	47
Outside learning spaces	51
Social spaces in and around school	37
Places where I can learn by myself	40
Other	10
No response	1
N = 196	

More than one answer could be put forward so percentages do not sum to 100
Source: NFER Survey on the effect of the school environment, 2007.

Table 4b – After Survey

Where do you learn best in your school?

	%
Classrooms	56
Learning resource centre/Library	23
Areas where there is a range of ICT	73
Sports hall	63
Practical spaces	51
Outside learning spaces	48
Social spaces in and around school	43

Places where I can learn by myself	40
Other	7
No response	3
N = 203	

More than one answer could be put forward so percentages do not sum to 100
Source: NFER Survey on the effect of the school environment, 2007.

The pattern of students' responses to the question of where they learnt best remained broadly similar across the two surveys. However, two areas did show noticeable differences. These were, firstly, the sports hall, which was ticked by an additional 17 per cent of students in the 'after' survey', and secondly, the learning resource centre/library, which was ticked by 16 per cent *fewer* students in the 'after' survey. A similar question asked students about where they most enjoyed learning in school (see Tables 5a and 5b).

Table 5a – Before Survey

Where do you most enjoy learning in your school?

	%
Classrooms	31
Learning resource centre/Library	28
Areas where there is a range of ICT	60
Sports hall	56
Practical spaces	40
Outside learning spaces	55
Social spaces in and around school	36
Places where I can learn by myself	35
Other	13
No response	2
N = 196	

More than one answer could be put forward so percentages do not sum to 100
Source: NFER Survey on the effect of the school environment, 2007.

Table 5b – After Survey

Where do you most enjoy learning in your school?

	%
Classrooms	28
Learning resource centre/Library	17
Areas where there is a range of ICT	74
Sports hall	65
Practical spaces	45
Outside learning spaces	40

Social spaces in and around school	39
Places where I can learn by myself	22
Other	6
No response	2
N = 203	

More than one answer could be put forward so percentages do not sum to 100
Source: NFER Survey on the effect of the school environment, 2007.

Students responded to the question about where they most enjoyed learning in a similar way to the previous question about where they learnt best: the one exception was classrooms – the proportion of students who said that they enjoyed learning in classrooms was half that of students who said it was where they learnt best.

There were a number of differences in the 'before' and 'after' surveys: the sports hall and ICT areas were ticked as areas where they enjoyed learning by more students in the 'after' survey', whereas the learning resource area/library, 'places where I can learn by myself', and outside learning spaces were ticked by fewer students in the second survey. As students completed the first survey during the summer and the second survey in December, timing could be a factor in the last of these differences.

Respondents to the teacher survey felt that general classroom teaching, practical lessons and demonstrations, and ICT and drama facilities were better or much better than before. On the other hand, teaching in the library/resource centre was thought to be less satisfactory than before.

A further question in the student survey asked about activities outside of normal lesson hours, and the responses are presented in Tables 6a and 6b.

Table 6a – Before Survey

Are there places in your school to do the following?

	Yes %	**No** %	**Not sure** %	**No response** %
Take part in activities before school begin	55	25	13	7
Take part in activities after school finishes	61	24	8	7
To go to at break times	58	22	14	6
To meet with your friends	74	12	8	6
N = 196				

A series of single response items

Due to rounding, percentages may not always sum to 100
Source: NFER Survey on the effect of the school environment, 2007.

Table 6b – After Survey

Are there places in your school to do the following?

	Yes %	No %	Not sure %	No response %
Take part in activities before school begin	24	38	29	9
Take part in activities after school finishes	76	12	7	5
To go to at break times	62	16	15	7
To meet with your friends	73	12	9	5
N = 203				

A series of single response items
Due to rounding, percentages may not always sum to 100
Source: NFER Survey on the effect of the school environment, 2007.

The responses to the two surveys are contradictory in that considerably fewer students in the ‘after’ survey thought there were places to take part in activities *before* school, whereas more thought there were places to take part in activities *after* school. As with the previous question, the time of the year could be a factor here. A similar number of students in both surveys thought there were places to go at break times and to meet friends.

2.3 School facilities

The questionnaire asked students about the facilities in their school and, in particular, how important certain aspects of furniture and equipment were in their school. Their responses are presented in Tables 7a and 7b.

Table 7a – Before Survey

How important are each of the following things to you when you are at school?

	Very Important %	Quite Important %	Not Important %	No response %
Appropriate classroom furniture when you are working	55	32	7	7
A good range of ICT equipment to help you learn	71	21	2	6
Good facilities and equipment in Science and Technology	62	26	5	8
Good Drama and Dance facilities	41	31	20	8
Good sports facilities	67	21	5	7
Good dining facilities for healthy eating	64	22	7	7
Enough equipment in the playground/outside Areas	52	27	16	6
Enough space to move between lessons	64	21	6	9
The right temperature in learning spaces	69	19	4	7
Enough lighting in classrooms and corridors	58	28	7	8
Nice, clean toilets	79	13	2	7
Nice, clean changing rooms	76	13	4	7
Good acoustics	45	30	11	14
Good ventilation	65	19	4	12
N = 196				

A series of single response items
Due to rounding, percentages may not always sum to 100
Source: NFER Survey on the effect of the school environment, 2007.

Table 7b – After Survey

How important are each of the following things to you when you are at school?

	Very Important %	Quite Important %	Not Important %	No response %
Appropriate classroom furniture when you are working	52	39	4	5
A good range of ICT equipment to help you learn	78	17	3	3
Good facilities and equipment in Science and Technology	63	29	5	3
Good Drama and Dance facilities	34	42	18	6
Good sports facilities	74	18	4	3
Good dining facilities for healthy eating	66	24	6	4
Enough equipment in the playground/outside Areas	52	32	13	3
Enough space to move between lessons	67	25	4	4
The right temperature in learning spaces	66	26	4	4
Enough lighting in classrooms and corridors	60	31	5	4
Nice, clean toilets	76	17	3	4
Nice, clean changing rooms	79	16	2	3
Good acoustics	43	42	10	4
Good ventilation	65	27	4	4

N = 203

A series of single response items
Due to rounding, percentages may not always sum to 100
Source: NFER Survey on the effect of the school environment, 2007.

There was little difference in the way students responded between the first and second surveys. This suggests that the movement from old to new school buildings does not significantly alter student perceptions of what is important in terms of facilities and various aspects of the school environment. In both surveys, the facilities the students thought most important were nice, clean toilets and changing rooms, and good ICT and sports facilities.

2.4 Learning opportunities

Students were asked about the various learning opportunities that were available to them in their school. In particular they were asked about the different ways in which they learned in their school and where this learning took place. Students were also asked to identify their favourite subject at school and the types of activities they enjoyed being involved in.

Table 8a – Before Survey

The following list gives examples of different ways you might learn in your school and the different places where your learning might take place (please indicate which of these apply to you)

Ways of working	%	Working spaces	%
Working on my own	54	Working in the resource centre/library	56
Working in small groups	83	Using drama/performing arts facilities	38
Working on whole class activities	51	Using outside spaces	73
Using ICT/new technologies	78	Using sport facilities	72
Working with students in different year groups	20	Working in classrooms	67
Having teacher demonstrations	46	Working in study areas	41
Practical lessons	76		
Project work	55		
No response	5	No response	8
N = 196			

More than one answer could be put forward so percentages do not sum to 100
Source: NFER Survey on the effect of the school environment, 2007.

Table 8b – After Survey

The following list gives examples of different ways you might learn in your school and the different places where your learning might take place (please indicate which of these apply to you)

Ways of working	%	Working spaces	%
Working on my own	63	Working in the resource centre/library	34
Working in small groups	83	Using drama/performing arts facilities	36
Working on whole class activities	52	Using outside spaces	67
Using ICT/new technologies	83	Using sport facilities	74
Working with students in different year groups	22	Working in classrooms	70
Having teacher demonstrations	52	Working in study areas	50
Practical lessons	83		
Project work	52		
No response	3	No response	5
N = 203			

More than one answer could be put forward so percentages do not sum to 100
Source: NFER Survey on the effect of the school environment, 2007.

Again, the patterns of responses seem to be similar across the two surveys, so student preferences about how and where to learn did not change significantly. There were indications, however, that slightly more students worked on their own (up nine per cent), used ICT/new technologies (up five per cent), had teacher demonstrations (up six per cent) and were involved in practical lessons (up seven per cent), after the move to the new buildings. In terms of *places* for learning, the most noticeable changes were a decrease (by 22 per cent) in the number of students working in the resources centre/library, and an increase (by nine per cent) in the numbers working in study areas.

Students were also asked about their favourite subjects in school, in order to assess whether the move to new buildings had made any impact upon curriculum preferences (see Tables 9a and 9b).

Table 9a – Before Survey

What are your favourite subject(s) at school? (please list your three favourite subjects):

	%
PE	55
Art	41
English	32
Science	26
Design technology/DT	18
N = 196	

More than one answer could be put forward so percentages do not sum to 100
An open-ended, multiple response question with the top five responses shown
Source: NFER Survey on the effect of the school environment, 2007.

Table 9b – After Survey

What are your favourite subject(s) at school? (please list your three favourite subjects):

	%
PE	69
ICT	40
Art	37
English	22
Mathematics	19
Science	19
Design technology/DT	16
Geography	16
N = 203	

More than one answer could be put forward so percentages do not sum to 100
An open-ended, multiple response question with the top eight responses shown
Source: NFER Survey on the effect of the school environment, 2007.

Over the course of the two surveys, PE consolidated its position as the most popular subject with students: 55 per cent of students identified PE is a favourite subject in the before survey and this increased to 69 per cent in the after survey, probably stimulated by the new sports facilities within the new school. ICT also saw a major increase in popularity (not in the top five subjects in the before survey, but second in the after survey and identified by 40 per cent of students). Mathematics and geography also increased in popularity. English was identified as a favourite subject by ten per cent fewer students in the after survey, and science by seven per cent fewer students.

Table 10a – Before Survey

Would you like to be involved in any of the following activities in your school?

	Yes, already Involved %	Yes, but no facilities at school %	No, don't want to be involved %	No response %
School Council	14	12	59	15
Sports team	39	24	28	10
Music group	12	14	60	14
Drama group	19	14	53	14
Dance group	13	19	54	14
Arts and Crafts	17	24	46	13
Homework club	9	7	69	15
Other	4	2	12	83
N = 196				

A series of single response items
Due to rounding, percentages may not always sum to 100
Source: NFER Survey on the effect of the school environment, 2007.

Table 10b – After Survey

Would you like to be involved in any of the following activities in your school?

	Yes, already Involved %	Yes, but no facilities at school %	No, don't want to be involved %	No response %
School Council	11	7	64	18
Sports team	43	14	34	9
Music group	12	8	64	16
Drama group	10	7	64	19
Dance group	10	8	63	19
Arts and Crafts	16	11	57	16
Homework club	6	7	69	18
Other	4	3	15	78
N = 203				

A series of single response items
Due to rounding, percentages may not always sum to 100
Source: NFER Survey on the effect of the school environment, 2007.

The figures in the second column of Table 10b, when compared with the equivalent figures in Table 10a, give an indication that, for all the activities listed, opportunities to be involved with these facilities/activities had increased, i.e. smaller proportions of students said that these facilities were not available in the after survey.

The next question in the survey asked students about the extent to which the community (in the form of adults and students from other schools) used their school's facilities. Their responses are presented in Tables 11a and 11b.

Table 11a - Before Survey

Do adults outside school and/or students from other schools use your school's facilities for learning or other activities?

	%
Yes	14
No	32
Not sure	45
No response	8
N = 196	

A single response item
Due to rounding, percentages may not sum to 100
Source: NFER Survey on the effect of the school environment, 2007.

Table 11b – After Survey

Do adults outside school and/or students from other schools use your school's facilities for learning or other activities?

	%
Yes	36
No	13
Not sure	44
No response	7
N = 203	

A single response item
Due to rounding, percentages may not sum to 100
Source: NFER Survey on the effect of the school environment, 2007.

It is clear that the move to new buildings had facilitated an increase in community use of the school's facilities. The proportion of students indicating that the facilities were used, for learning or other activities, increased from 14 per cent in the before survey to 36 per cent in the after survey.

2.5 Views on the new school

The questionnaire asked students about their views on the new school. In particular they were asked whether they had been asked for their views about the design of the new schools (see Tables 12a to 14b).

Table 12a – Before Survey

Since you started at your current school, have you been asked your views about the design of the new school that is being built and due to be opened in September?

	%
Yes, I've been asked a lot	12
Yes, I've been asked a few times	39
No, I haven't been asked at all	35
No response	14
N = 196	

A single response item
Due to rounding, percentages may not sum to 100
Source: NFER Survey on the effect of the school environment, 2007.

Table 12b – After Survey

Were you asked your views about the design of your new school that opened in September

	%
Yes, I've been asked a lot	19
Yes, I've been asked a few times	39
No, I haven't been asked at all	32
No response	9
N = 203	

A single response item
Due to rounding, percentages may not sum to 100
Source: NFER Survey on the effect of the school environment, 2007.

Table 13a – Before Survey

Would you liked to have been asked about the design of your new school?

	%
Yes	32
No	17
Don't really mind	51
No response	
N = 69	

A single response item filter question
Due to rounding, percentages may not sum to 100
Source: NFER Survey on the effect of the school environment, 2007.

Table 13b – After Survey

Would you liked to have been asked about the design of your new school?

	%
Yes	23
No	34
Don't really mind	42
No response	2
N = 65	

A single response item filter question
Due to rounding, percentages may not sum to 100
Source: NFER Survey on the effect of the school environment, 2007.

Table 14a – Before Survey

Did people take notice of your views about the new school that is being built?

	%
Yes, my views were taken into account	12
Yes, some of my views were taken into account	17
No, my views were not taken into account	16
I wasn't asked about my views	11
Not sure	36
No response	8
N = 100	

A single response item filter question
Due to rounding, percentages may not sum to 100
Source: NFER Survey on the effect of the school environment, 2007.

Table 14b – After Survey

Did people take notice of your views about the new school that is being built?

	%
Yes, my views were taken into account	14
Yes, some of my views were taken into account	18
No, my views were not taken into account	13
I wasn't asked about my views	10
Not sure	40
No response	6
N = 119	

A single response item filter question
Due to rounding, percentages may not sum to 100
Source: NFER Survey on the effect of the school environment, 2007.

The figures presented in Tables 12a and 12b suggest that there was a small increase in the proportion of students asked for their views about the design of the new school *after* the move into the new building had taken place. In the before survey just over half of the students (51 per cent) indicated that they had been asked for their views (either a few times or a lot), but this figure increases to 58 per cent in the after survey. There were also small increases in the proportions of students who felt that their views had been taken into account (Tables 14a and 14b). On a slightly more negative note, the responses in Tables 13a and 13b suggest a possibility that some students may have become rather 'tired' of being consulted (or they felt that this was no longer necessary): the proportion who said that they would like to have been asked about the design of their new school decreased from 32 per cent to 23 per cent in the second survey.

Most of the eight teachers who responded to the teacher survey said that they felt that they had had some opportunities to give their views about the design of the new school, and felt that some of their views had been taken into account. Unlike the students, however, they were keen to have more consultation.

Table 15a – Before Survey

In the space below please write one or two sentences saying what you think about the design of your new school.

	%
Good/Fantastic/Brilliant	20
Nice	18

Colourful	9
Good design	8
Spacious	7
No response	13
N = 100	

More than one answer could be put forward so percentages do not sum to 100
An open-ended, multiple response filter question with the top five responses shown
Source: NFER Survey on the effect of the school environment, 2007.

Table 15b – After Survey

In the space below please write one or two sentences saying what you think about the design of your new school.

	%
Colourful	24
Good design	11
Big	11
Nice	9
Good/Fantastic/Brilliant	9
OK/alright	9
Spacious	7
Modern/state of the art	5
No response	23
N = 203	

More than one answer could be put forward so percentages do not sum to 100
An open-ended, multiple response filter question with the top five responses shown
Source: NFER Survey on the effect of the school environment, 2007.

It is apparent that by the time of the second survey, students were rather more impressed with the colour and size of the buildings, though other dimensions, such as space and quality of design featured in both sets of survey responses.

Teachers were very positive in their descriptive responses. They described the new buildings as 'generally excellent', 'well designed and thought out'. One said that the programme was 'a fantastic initiative', and another commented that: 'I feel proud to teach in such an inspirational and exciting school'.

2.6 The future

Students were asked questions about how well they thought they would do at school (Tables 16a and 16b) and whether they would recommend the school to others (Tables 17a and 17b).

Table 16a – Before Survey

How well do you think you will do in your assessments at the end of the year?

	%
Very well	22
Quite well	38
OK	27
Not very well	5
No response	8
N = 196	

A single response item
Due to rounding, percentages may not sum to 100
Source: NFER Survey on the effect of the school environment, 2007.

Table 16b – After Survey

How well do you think you will do in your assessments at the end of the year?

	%
Very well	24
Quite well	43
OK	21
Not very well	2
No response	10
N = 203	

A single response item
Due to rounding, percentages may not sum to 100
Source: NFER Survey on the effect of the school environment, 2007.

For whatever reason, students did have slightly improved confidence levels by the time of the second survey. For example, the proportion who felt that they would do very well in their end of year assessments increased slightly, from 22 per cent to 24 per cent, and the proportions expressing the view that they would do quite well increased from 38 to 43 per cent.

Table 17a – Before Survey

Would you recommend your school to another student who was thinking of coming to your existing school?

	%
Yes, definitely	17
Yes, probably	41
No	15
Not sure	18
No response	9
N = 196	

A single response item
Due to rounding, percentages may not sum to 100
Source: NFER Survey on the effect of the school environment, 2007.

Table 17b – After Survey

Would you recommend your school to another student who was thinking of coming to your existing school?

	%
Yes, definitely	31
Yes, probably	39
No	7
Not sure	14
No response	9
N = 196	

A single response item
Due to rounding, percentages may not sum to 100
Source: NFER Survey on the effect of the school environment, 2007.

Students' image of the school had also improved. By the time of the after survey, 31 per cent of respondents said that they would 'definitely' recommend the school to another student who was thinking of coming to the school, compared with only 17 per cent in the before survey.

There was also an improvement in students' further educational expectations, with the proportion expecting to stay on in the sixth form or to go to college increasing from 64 per cent to 77 per cent (Tables 18a and 18b). The proportion expecting to go into training or employment declined from 54 per cent to 40 per cent. The proportion anticipating going to university, however, declined slightly from 37 per cent to 35 per cent.

Table 18a – Before Survey

What do you think you will do when you leave school?

	%
Stay at school in the sixth form	31
Go to college full-time	33
Go on a training course full-time	16
Get a job with training	30
Get a job without training	8
Go to university	37
No idea yet	32
No response	8
N = 203	

More than one answer could be put forward so percentages do not sum to 100
Source: NFER Survey on the effect of the school environment, 2007.

Table 18b – After Survey

What do you think you will do when you leave school?

	%
Stay at school in the sixth form	41
Go to college full-time	36
Go on a training course full-time	10
Get a job with training	24
Get a job without training	6
Go to university	35
No idea yet	24
No response	8
N = 196	

More than one answer could be put forward so percentages do not sum to 100
Source: NFER Survey on the effect of the school environment, 2007.

The final question in the survey asked students if they felt that their school was environmentally friendly. The responses to this question, presented in Tables 19a and 19b, provide strong evidence that the new school was seen as being environmentally friendly. The proportion of students agreeing that the school had this quality more than doubled, from 24 per cent to 48 per cent.

Table 19a – Before Survey

Do you think your school is environmentally friendly?

	%
Yes	24
No	30
Not sure	40
No response	7
N = 196	

A single response item
Due to rounding, percentages may not sum to 100
Source: NFER Survey on the effect of the school environment, 2007.

Table 19b – After Survey

Do you think your school is environmentally friendly?

	%
Yes	55
No	8
Not sure	25
No response	12
N = 196	

A single response item
Due to rounding, percentages may not sum to 100
Source: NFER Survey on the effect of the school environment, 2007.

3. Summary and conclusions

3.1 The context

Before summarising the key findings that have emerged from these surveys, it is worth re-emphasising the context of the study and briefly setting out the caveats that need to be applied to the research. In particular, in considering these findings, the following points need to be borne in mind:

- The surveys were conducted at particular points of time and, although their timing was logical, it should be remembered that these are ‘snapshots’ of student attitudes and such attitudes will clearly change and evolve over time.

- Although the construction and occupation of new buildings is a major initiative, and as such is likely to have a considerable effect on student attitudes, it also needs to be borne in mind that other factors may have had an effect, including any pastoral, curricular or staffing changes within the school.

- The survey was conducted in only one school, so there may be particular school factors (physical, social, administrative and educational) that may have affected student attitudes. It is to be hoped, however, that, as this was one of the first BSF schools, at least some of the findings should have a more general applicability. The questionnaire certainly worked well and could be used as a template in other schools with changing environments.

3.2 Summary and conclusions

On the whole the findings from the before and after surveys were very positive. There is a good deal of evidence to indicate that student attitudes had become more positive after the move into the new school buildings. In particular the proportions of students:

- who said that they **felt safe** at school most or all of the time increased from 57 to 87 per cent
- who said that they **felt proud** of their school increased from 43 to 77 per cent
- who said that they **enjoyed going to school** increased from 50 to 61 per cent

- who perceived that **vandalism** was at least ‘a bit of a problem’ in their school decreased from 84 per cent of respondents to 33 per cent
- who perceived that **bullying** was a big problem decreased from 39 per cent of students in the ‘before’ survey, to 16 per cent in the ‘after’ survey
- who expected to **stay on in the sixth form** or to go to college increased from 64 per cent to 77 per cent.

As noted in the previous section, it is not possible to attribute a ‘causal link’ between the improved attitudes of the students and the move to the new BSF building, but the numbers and levels of positive findings do suggest a strong association between the move to the new surroundings and improvements in students’ outlooks regarding their experience of school and their expectation for the future.

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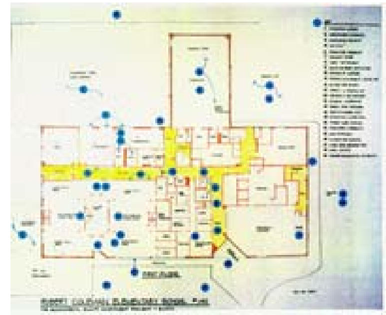
The Relationship between Environmental Quality of School Facilities and Student Performance

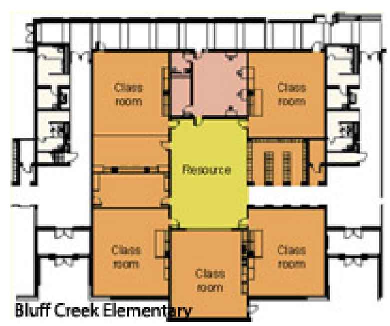


Presented by Jeffery A. Lackney, Ph.D., A.I.A.
Thursday, September 23, 1999

As part of a Congressional Briefing to the U.S. House of Representatives Committee on Science
Sponsored by the Environmental Energy Study Institute (EESI)

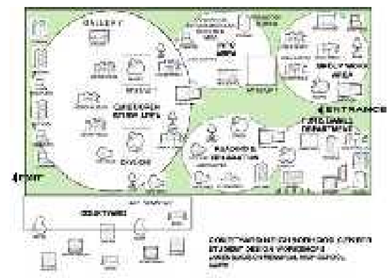
Energy Smart Schools: Opportunities to Save Money, Save Energy and Improve Student Performance

Congressman Udall, members of the Committee on Science, members of the audience, ladies and gentlemen, I am glad to be here with you today. I am here to discuss the state of empirical research on the impact of educational facilities on student behavior, attitudes and performance. What we know comes from research from a broad array of disciplines ranging from social and environmental psychology, education, architecture and human-factors engineering.



What is the connection between school buildings and education? Is it one of simply housing children and teachers who will get on with their work independent of the condition and character of the buildings they inhabit? Or is the connection more intimate - that sound sustainable buildings designed in particular ways will aid the goals of education - both student social development and academic achievement? I will argue that school buildings are of critical importance to the teaching and learning process. I will review a selected number of excellent empirical studies conducted over the past 30 years that have shown an explicit relationship between physical characteristics of school buildings and educational outcomes.

Historically, the assumption has been that as long as the basic physical requirements of the school building



are met -- minimum standards for classroom size, acoustics, lighting, heating and air conditioning - the child's learning depends in large part on pedagogical, psychological and social variables. I will argue that buildings are much more than preliminary requirements for the learning process.

I and others in the research community take the view that the factors responsible for student achievement are ecological - they act together as a whole in shaping the context within which learning takes place. The physical setting -- the school building - is an undeniably integral part of this ecological context for learning.

There is now considerable empirical support for the argument that a variety of sustainable design characteristics that can have a significant influence on student behavior and academic achievement. Physical and environmental conditions that I will discuss today include full-spectrum and natural lighting, the reduction of noise through proper location and siting of schools, optimal thermal conditions, sick buildings and indoor air quality, school size and class size and embedding schools within their communities.

Full-Spectrum and Natural Lighting

We have known for some time that environmental lighting exerts profound biological effects on humans, in addition to providing visual stimulus by controlling several glands and many metabolic processes as well as serving as a biological timer for biological rhythms. Illumination appears to be so important that even seasonal mood changes as strong as depression have been treated successfully merely by increasing the bright, white light in a person's environment (Rovner, 1982).

In a typical study (Kleiber, 1973) testing differences between full-spectrum lighting and cool white fluorescent lighting commonly used in institutional settings, it was found that physiological measures indicated that most subjects showed less fatigue after a study session in natural light than in a traditionally illuminated instructional environment.

Many students had better achievement when they were tested in classrooms with 85 or more footcandles of light, in contrast with their scores in a classroom with fewer than 65 footcandles environment; others achieved less well (Mayron, et al, 1974).

Individual learning styles often can mask attempts to link performance to lighting levels. One study investigated performance based on predetermining student lighting level preferences. Students were tested for reading speed and accuracy on a reading test in an extremely bright and then in an extremely dim instructional setting. Scores on both reading speed and accuracy were significantly higher when the illuminated instructional environment matched the student's diagnosed learning style preference for light. (Dunn, Dunn & Price, 1979).

From these studies we can conclude that teachers must be able to provide a combination and variety of well-lit and dimly-lit environments for reading within a classroom. Children should be encouraged to sit where they feel most comfortable, and teachers should experiment with placing restless students into softly lit sections and reversing that procedure for listless, unresponsive students (Dunn et al., 1985).

Under improved lighting conditions, using full-spectrum fluorescent tubes can show dramatic improvement in some children's behavior in the classroom (Ott, 1976). In one study, children were placed in four first-grade windowless classrooms, two with standard cool-white fluorescent tubes and fixtures and two with full-spectrum fluorescent tubes more closely duplicating natural daylight. Students in standard lighting were observed fidgeting to an extreme degree, leaping from their seats, flailing their arms, and paying little attention to their teachers, while the students in the full-spectrum lit classrooms settled down more quickly and payed more attention to their teachers. The two classrooms with standard white light were then replaced with full-spectrum as well. Subsequent observation found that students' behavior appeared calmer and more interested in their work. The results of this study were used by the researcher to indicate that hyperactivity is partly due to a radiation stress condition and that supplying that part of the visible spectrum lacking in standard artificial light sources may have some impact on relieving that condition.

Reduction of Noise Through the Proper Location and Siting of Schools

It is well accepted in the scientific community that prolonged exposure to high-intensity noise in community or work settings is often harmful to the health and behavior of large segments of the exposed populations. Noise in the learning environment can originate from within as well as outside the school building. Both forms of noise can have major affects on student behavior and in some cases achievement.

A review of a series of studies in the United States between 1980 and 1986 concluded there are significant increases in blood pressure associated with schools being near noisy urban streets (Evans, Kliewer & Martin, 1991). Other findings related to location include German and Russian studies (Berglund & Lindvall, 1986) again indicating increased systolic and diastolic blood pressure in middle school children in schools close to noisy urban streets, and abnormally high blood pressure in children residing around airports.

Exposure to traffic noise at elementary schools also has been associated with deficits in mental concentration, making more errors on difficult tasks, and greater likelihood of giving up on tasks before the time allocated has expired.

Furthermore, another study conducted in Los Angeles (Cohen, Evans, Stokols & Krantz, 1986) found blood pressure does not habituate or decline with continued noise exposure over time; that is, children don't get used to noise.

In effect, then, the location of schools is of critical importance if they are to be sustainable for effective teaching and learning.

There is increasing evidence of noise effects on human performance that persist outside of the noisy environment. It is important to note that all studies involving children are correlational. One of the deficits in achievement scores of children attending noisy schools is that noise interferes with the teaching-learning process, thus resulting in a cumulative and progressive deficit. Noise may for example decrease teaching time for forcing teachers to continuously pause or by making it difficult for the student and teacher to hear one another (Crook & Langdon, 1974). Other possible explanations include noise-produced influence on children's information processing strategies, feelings of personal control as well as their level of arousal (studies referenced in Cohen & Weinstein, 1981; 47).

Optimal Thermal Conditions

Thermal comfort has been shown to influence task performance, attention spans and levels of discomfort. In general, historical empirical studies going back 50 years have indicated that temperatures above 80 degrees F tend to produce harmful physiological effects that decrease work efficiency and output (McGuffy, 1982). Thermal conditions are below optimal levels affect dexterity, while higher than optimal temperatures decrease general alertness and increase physiological stress.

One researcher (Harner, 1974) when reviewing optimal temperature levels for the performance found that reading and mathematical skills were adversely affected by temperatures above 74 degrees F. Reading speed and comprehension were most affected by temperature. A significant reduction in reading speed and comprehension occurred between 73.4 degrees F and 80.6 degrees F. This researcher also found that achievement is mathematical operations such as multiplication, addition and factoring have been shown to be significantly reduced by air temperatures above 77 degrees F.

Sick Buildings and Indoor Air Quality

One area of concern in building design has been the thermal 'tightening' of buildings for energy conservation in the 1970s which may be one of the causes of a variety of pathogenic factors in children in so called 'sick' school buildings (Evans, Kliewer & Martin, 1991). These factors may be affecting not only performance but the overall physical health of children. Children in 'sick buildings' have been found to exhibit clear signs of sensory irritation, skin rashes, and mental fatigue - all factors with the potential of decreasing the ability of students to perform. The strategies for improving indoor air quality such as increasing levels of fresh-air intake and increased ventilation rates in buildings have shown that these mediating factors can be eliminated insuring that students can remain concentrated on the tasks of learning.

School Size and Class Size

I have deliberately left the issue of size - both school and class - for the end since they have been discussed at great length publicly and they often overshadow other extremely important environmental qualities such as lighting, thermal conditions and noise. Additionally, school and class size are explicitly social/organizational variables first, and physical variables second. That is, if we consider decreasing school size and class size, which I believe we should and are attempting to do finally, we are in effect implicitly accepting the notion that issues of density and the physical scale of our buildings are important to the student achievement as well.

In the now classic Big School, Small School study conducted by Roger Barker and Paul Gump (1964), small schools (100-150), in comparison with large schools (over 2,000) offer students greater opportunities to participate in extracurricular activities and to exercise leadership roles. In particular, participation in school activities, student satisfaction, number of classes taken, community employment, and participation in social organizations were all superior in small schools relative to large schools.

A review of over 300 subsequent studies (Garbarino, 1980) indicated that small schools (500) also have lower incidence of crime levels and less serious student misconduct.

In a review of research conducted on the relationship between school size and academic achievement (Fowler, 1992) there was found to be a negative relationship between math and verbal ability tests and elementary school size controlling for socio-economic differences (Kiesling, 1967 cited in Fowler, 1992). Additionally, smaller elementary schools particularly benefit African-American students' achievement (Summers & Wolfe, 1977 cited in Fowler, 1992).

Class size research, most notably the longitudinal research represented by the Tennessee

Student/Teacher Area Ratio STAR Project and the follow-up Lasting Benefits Study, points directly to a social and physical link to achievement (Achilles, 1992; Finn & Achilles, 1990). Project STAR followed 6,500 children from kindergarten through third grade. Children in smaller classes (13-17 per room) outperformed those in regular-sized classes (22-25 per room) as measured by test scores such as the Stanford Achievement Test. In the early grades, children in smaller classes outperformed children from regular class sizes in all subjects, but especially in reading and mathematics test scores with average improvements of up to 15%. Smaller classes were especially helpful for children in inner-city schools. A follow-up study that used the same schools, students and tests has shown that students previously in small classes demonstrated statistically significant advantages two years later over students previously in regular sized classes. Performance gains ranged from 11-34%.

Not explicit in the STAR Project research are the explanations for why such as relationship exists. One possible explanation is that, in addition to more and higher quality student-teacher interactions possible in a smaller class, spatial density and crowding are also reduced. In a study of younger children (Loo, 1976), an increased density can induce stress in children thereby increasing aggressive behavior and distraction in younger children.

Embedding Schools within their Communities

A broader notion of sustainable schools is that of the formation of sustainable communities within which they are embedded. Here I am being more speculative, but based on principles of sustainable community design. We know that small schools benefit students socially and academically, while smaller school buildings consume less energy. Additionally, the benefits of smaller neighborhood schools -- serving as true community centers -- offer a plethora of opportunities. The use of school facilities can be shared with a variety of community organizations fostering meaningful inter-organizational partnerships. Facilities that are close to the neighborhoods of the children they serve provide could opportunities for children to walk and bike with the added public health benefit of increasing their physical activity, rather than relying on more costly modes of transportation. Finally, school facilities that act as true community centers could serve the broader societal goals of providing the setting for meaningful civic participation and engagement at the local level.

Building Condition, Building Life-Cycle and Facility Management

Although we have been talking about critical public policy issues that must effect a change in how we conceive and design school buildings from now into the 21st century, when we think of sustainability, we must think long-term - we must think about the building life-cycle. A well-designed sustainable school building will certainly get us out of the starting blocks on a better footing, but a well-managed school building will ultimately be the true test of our sustainable design principles.

The good proxy measure of the quality of facility management is that of building condition. School buildings deteriorate with age and since a building's age is a factor in building deterioration, the condition of older buildings depends to a large extent on the adequacy of maintenance and operations. A 1991 correlational study of building condition and student achievement in the Washington D.C. Schools, found that educational building conditions were hampering student performance, and estimated that improved facilities could lead to a 5.5% to 11% improvement on standardized tests (Edwards, 1991).

In a study this researcher conducted a few years ago assessing environmental quality in five Baltimore City public elementary schools, a simple correlation was found between the number of high-priority environmental concerns expressed by teachers and the change in the percentage of student academic improvement during a two-year period (Lackney, 1996). The most likely explanations for this correlation may be due to concerns over physical comfort and health and classroom adaptability, both characteristics of a sustainable school. This study is only suggestive, based on self-reports of teachers, and cannot be generalized beyond the sample, however, it does suggest that we pay more attention to building life-cycle issues when talking about sustainable schools.

In summary, all the physical factors I have mentioned - full-spectrum and natural lighting, the reduction and control of noise, the location and siting of schools, optimal thermal conditions, and school size and class size, as well as building condition -- can have a mediating effect on a variety of variables known to have a link to student achievement: time-on-task, student-teacher interactions, classroom interruptions and student participation.

In addition, the quality of the learning environment is known to affect teacher behavior and teacher attitudes towards continuing to teach (Johnson, 1990), something we have not been able to touch upon here, which can have an additional mediating effect on student behavior and attitudes.

To conclude, the evidence is overwhelming that school buildings are of critical importance to the teaching and learning process. It is my belief that the application of sustainable design principles discussed in this briefing, if applied early in the school design process will most certainly have a positive influence on the bottom-line indicators of quality in education into the next century.

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redesigning the classroom environment

The layout of the classroom affects the behaviour of all those in it.

In my work as an educational psychologist I often encounter the difficulties that the physical environment poses to class teachers and children and I have been very struck by the way in which the layout of a classroom affects the behaviour of all those in it.

This was highlighted to me, when working with a group of teachers on an early years curriculum, by a teacher from New Zealand. She had been very shocked by the learning environments offered in old Victorian school buildings and the lack of recognition given to how they impact the staff and pupils.

We listened in awe at her descriptions of new schools in New Zealand where the environments had been designed for children. There were "soft" areas, areas with different temperatures, a drinking area in every classroom, fruit available for a snack at any time, ventilation and light sensitive to the weather. In short, the whole environment was dedicated to promoting feelings of well-being and therefore motivation to learn and focus.

Does this sound like your classroom, your school? Some of us may be fortunate enough to work in a new purpose-built school, but for the majority this is not the case.

But there are different ways to think and use space. This article aims to bring creative thoughts to the process. Before the start of a new term and as you are taking down the decorations from last term, creativity may help you to rethink the use of space and resources in your classroom.

Rationalising space
A good way to begin thinking about your classroom is to consider what you value about any spaces you experience. Also reflect on how these spaces make you feel and the effect they have on your behaviour and thinking.

Good starting points might be your favourite shop or art gallery. What is it that you value about the way merchandise/exhibits are presented and how does it enhance/detract from your experience.

We live in a society that often seems to value high levels of stimulation. This can lead to confusion, tiredness and lack of clarity. There is too much to take in and this affects our thinking. Think of a store or display that has this effect on you. This is also the case in classrooms and particularly so for children still learning to focus and discriminate. We need to think how to best facilitate these skills by the environments we offer.

Looking at your classroom from this point of view one can see that less can mean more and children will benefit from clarity of space and function. This helps them to "read" the space and this is then a very good environment in which to learn.

In an attempt to be "stimulating" some classrooms can go overboard on displays and materials that can be overstimulating and confusing to the child.

Space to move
The use of space is vital in its flexibility and ease of movement. It is very important that children don't feel squashed and uncomfortable. Just think about when this happens to you as an adult and how uncomfortable it feels to have another person encroach on your space – for example, on an aeroplane. Yet we often expect this of children on a daily basis.

There should be enough space for children to cross and be beside one another without banging into their fellow pupils. There should be sufficient space for every child to sit comfortably during story time and ideally sit in a circle with 2/3 inches between each child for circle time activities.

Space for identity
Every child and adult should have a designated drawer for work materials and a designated space for their personal belongings. Every adult should have the same

Working spaces that fit the individual
Furniture should be selected that is the right size for the age group of children and has flexibly of function. (So often children are working with the wrong size furniture.)

Each piece of furniture should have a clear purpose and be used regularly otherwise it should go. Do you, for instance, really need a teacher's desk in the classroom – exactly what function does it fulfil?

Each child should have enough room to work so that their arms do not bang into one another. In the case of left-handers they should be sat at the left hand corner of the table with their left arm having room to move. Left-handers may also need to sit at a different angle to their work and they need space to do this.

For any child with motor co-ordination difficulty – for dyspraxic pupils this is a key issue. They may also need the provision of a sloping work surface and a foot rest .

Children with attention difficulties need consideration of a separate work place with minimal distraction visually and socially for specific tasks. This should be seen as a requirement rather than a punishment and a variety of children may choose to work in this way at different times. Children should be encouraged to think about how they work best at different tasks and be praised for this reflection.

Children with Asperger's syndrome will find issues of space very important and they will need to know that their space will be respected. They will find an uninvited intrusion into their space very threatening.

Many school buildings have windows, doors and displays that are at adult level. This is stressful to children when it is a constant feature of their daily environment. Imagine if everything you were asked to use each day at work was too small.

Displays should be at child level and they should be very clear in their message and purpose according to the appropriate developmental stage of the child. So the young child needs experiential displays while the older child needs clearly labelled displays that highlight key points.

Teaching organisational skills
As children develop, you should expect a greater degree of autonomy. This can be reinforced by the layout of the room and storage so that pupils can increasingly "help themselves". These are such important life/organisational skills and are particularly pertinent for children with Special Needs.

Healthy environments
There is evidence that many classrooms are unhealthy places to be especially in the long winters we have in this country. Ventilation is vital for young busy children. I am often struck by the lack of air in the rooms I visit in

schools and how this must be affecting the children and adults in them.

Research has shown that many children in schools are often very dehydrated. They should have access to drinking water and be allowed to drink whenever they choose. This has great benefits for their present and future health, the teachers should be drinking water too.

Finally, an uncluttered space, well placed furniture, organised materials, simple and clear displays, and carefully considered seating arrangements will all assist in keeping the environment clean and healthy. And most importantly they will all enhance the teaching and learning of all those working there

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2009-2020 CAPITAL IMPROVEMENT PLAN

DESIGN RESOURCES

ACOUSTICS, AIR, DAYLIGHTING, GREEN DESIGN

Acoustics: The Impact of Classroom Acoustics on Scholastic Achievement
Air: Do School Facilities Affect Academic Outcome?
Air: Indoor Air Quality and Student Performance
Daylighting: Daylighting in Schools
Daylighting: An Investigation into the Relationship Between Daylighting and Human Performance (Condensed)
Daylighting: An Investigation into the Relationship Between Daylighting and Human Performance (Detailed)
Daylighting: Daylighting in Schools, Grades K-12
Daylighting: Classroom Lighting Know How
Daylighting: More Daylight Means Healthier Environments
Daylighting: A Study of Office Worker Performance and the Indoor Environment
Green Design: Good Buildings, Better Schools
Green Design: Highlights of High Performing Schools Design

The MISSION of the Timberlane Regional School District is to engage all students in challenging and relevant learning opportunities, emphasizing high aspirations and personal growth.

17th Meeting of the International Commission for Acoustics, Rome, Italy, Sept. 2-7, 2001
The Impact of Classroom Acoustics on Scholastic Achievement

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What are the relationships between scholastic achievement and acoustics in learning spaces? Answers to this difficult question are needed to support setting objective limits for noise and reverberation. Good acoustics is necessary in classrooms and learning spaces whenever speech communication is important to the learning process. It is clear that excessive noise and reverberation interfere with speech communication and thus present acoustical barriers to learning. Acoustical allowances are needed to accommodate differences in student abilities, health, and scholastic preparation. This paper reviews speech communication criteria and studies that have linked scholastic performance with acoustical noise or reverberation. Some studies link aircraft noise with delayed language acquisition, reading deficiencies, reduced motivation, and long-term recall of learned material. Others link ground transportation noise with reduced academic achievement. Aside from reduced speech intelligibility, little data were found to gauge the impact on learning achievement from heating, ventilating, and air conditioning noise; from the noises of students interacting in cooperative learning environments; or from reverberation. Despite their incomplete nature, some useful inferences can be drawn from these studies. For example, evidence for cumulative impact of poor acoustics on scholastic achievement suggests that good acoustics be made a high priority for children in lower grades.

INTRODUCTION

The ability to understand isolated speech material consisting of single words or sentences in an acoustic environment with varying amounts of background noise and reverberation has been well studied in laboratory settings and documented in the literature for persons with normal hearing[1-3], persons with impaired hearing[4, 5] and students for whom English is a second language [6] All of these auditory challenges exist in the school classroom with an environment for which the most significant speech communication can be connected discourse or, for the youngest learners, new words or phrases containing unfamiliar sounds or phonemes. Criteria for speech intelligibility as measured under laboratory conditions are clearly related to speech reception in this classroom acoustic environment but direct correlation between laboratory testing of speech intelligibility and student achievement in school environments is more tenuous. For example, Evans [12] has shown evidence for adverse effects on children's health and learning due to chronic noise exposure. Development of the link between acoustics and learning is vital to support improvements in classroom acoustics. The classroom serves as a communication channel for learning essential academic, social, and cultural skills for all students. All knowledge-based societies should do what is necessary to eliminate acoustical barriers to learning.

Noise as an acoustical barrier to learning

Noise level and teacher vocal strain

Excessive noise can only be partially ameliorated by a teacher raising his or her voice level and then only at the potential cost of voice fatigue. From a study by Pearson, et al[7], the average A-weighted sound level, LA at 1 meter from male and female teachers was found to increase from a level of 60 dB in quiet (average for normal and raised voice effort) to a level of about 62 dB in an A-weighted background noise level of 35 dB to 67 dB in a background of 45 dB and then increasing approximately dB for dB as the background noise level increased above 45 dB. Thus, while the teacher attempts to maintain approximately the same signal to noise ratio in a noisy room, the strain on the teacher's voice increases causing voice fatigue and results in teacher absenteeism. [8]. In addition; there is evidence of a reduced number of verbal interactions between teachers and students in noisy classrooms, although its impact on student achievement is not known.

From measurements of background noise in 56 classrooms in 5 different studies in the U.S., the average A-weighted background noise level was roughly normally distributed with a mean of 45 dB and a standard deviation of 8 dB. Thus, statistically, these very limited data suggest that 28% of the nations' schools may have background noise levels in excess of 50 dB. This 28 % figure is cited as a crude basis for comparison with results from a US Government Accounting Office survey [9] which found that 28% of the nation's schools reported "acoustics for noise control" as their top environmental problem. This suggests that the 28% figure from this survey may be a substantial understatement of the problem of acoustic barriers in schools since a background noise level of 50 db is 15 dB above the recommended limit included in a US standard for classroom acoustics now approaching a final draft. [10] It also suggests that the average voice level for a teacher in many classrooms could be 10 dB or more above their average (normal and raised) level in quiet - further validation of the prevalence of voice fatigue for teachers.

A teacher cannot effectively compensate for the acoustical barrier of excessive reverberation in a classroom. Raising the voice level provides little compensation. What, now is the link between the classroom acoustic environment and the scholastic achievement of students - i.e., what is the effect of the acoustic barriers?

Scholastic Achievement and The Acoustical Environment

Educational research studies[11] show that learning is dependent on the ability to communicate with spoken language and that perception of spoken language is the foundation for the ability to read and write.12 As much as 60% of classroom learning activities typically involve listening to, and participating in, spoken communications with the teacher and other students. It would be fully expected, therefore, for disruption of this communication to affect students' scholastic achievement.

For this paper, we mention, but make no attempt to document, the added acoustical barriers in the classroom for students with hearing impairments, learning disabilities or for those who are not learning in their native language. These added burdens simply compound the negative effects of these barriers to scholastic achievement. This omission is not meant to minimize their importance. Concern for the hearing handicapped, was an important motivating force that inspired much of the current effort to improve classroom acoustics. [10]

In one pioneering study of noise and reading in a home setting, Cohen, et al[13] measured reading and auditory processing among children living on different floors of an apartment building located over a busy highway in New York City. They found that for socio-economically-equivalent children, the higher the floor of residence, the lower the background noise level and the higher the reading scores.

In a series of three studies carried out on a school located within 67 m (220 ft.) of an elevated urban train track, Bronzaft and McCarthy[14] and Bronzaft [15] studied the reading scores of 2nd to 6th grade children in classrooms facing the tracks and in classrooms on the other side of the building facing away from the tracks. In the first study[14] (1975), it was found that children in the lower grades exposed to the noisy side were three or four months behind in reading scores relative to the children on the quieter side and as much as 11 months behind for the higher grades.

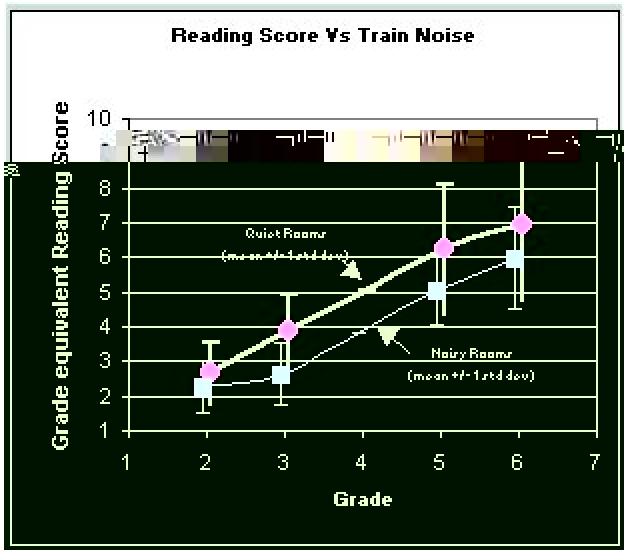

FIGURE 1. A study by Bronzaft and her colleagues showed that children exposed to the noisy side of a school building achieved lower reading scores than students on the quiet side.

After a subsequent effort succeeded in reducing the track noise by 3 to 8 dB on both sides of the school, further tests were conducted to determine if the achievement differences diminished.. [15] As shown in Fig, 1, a substantial difference remained in the reading scores between "noisy" and "quiet" classrooms. The students in each classroom were comparable in all respects and were receiving the same type of instruction. The data in Fig. 1 indicate that the reading scores for the children in "noisy" classrooms are approximately one year behind those in the "quiet" rooms - the rooms away from the rail track. There is some indication in the data that this time lag in reading scores may be slightly less for the lower grades, which is consistent with the 1975 study. There may be two plausible explanations of this effect: 1) it was observed that the teacher spent more one-on-one time with the students in the lower grades thus tending to minimize the detrimental effects of noise on their speech communication - a trend just the opposite of what might be expected for background noise effects on learning for younger vs. older children or 2) a hypothesized compounded effect of reduced learning for children in noisy classrooms as they progress through their grades. There are no known data to validate either possibility.

Another classic study on noise effects on scholastic achievement was carried out by Lukas, et al[16] in 14 schools in Los Angeles, California, located at different distances from freeways. The differences in distance from the freeway caused the background noise in the classrooms to differ by up to 19 dB between the noisiest and quietest classrooms. Reading and math grade-equivalent scores and general classroom behavior patterns were evaluated in 74 classrooms, approximately 19 in each of the "noisy" and "quiet" schools in third and sixth grade classes. The results of this study for reading scores are shown in Fig. 2 in terms of the grade equivalent reading scores as a function of the C-weighted background noise level in the classroom.

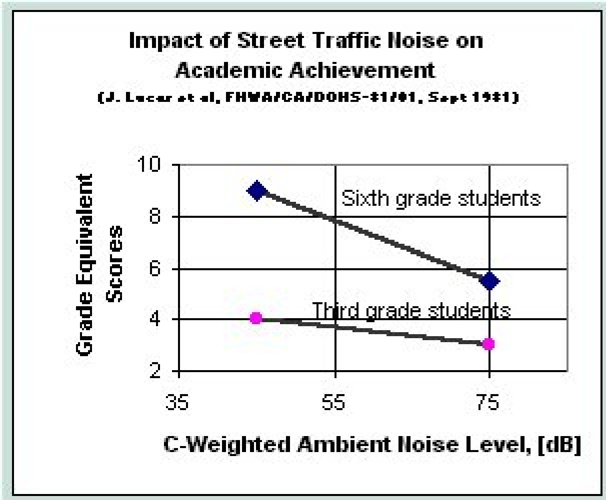

FIGURE 2. A study by Lucas et al showed that academic achievement was higher for students exposed to lower levels of noise from freeways.

Lukas, et al, used the C-weighted level because it provided the best correlation with the reading scores. However, the average difference between the C- and A-weighted noise levels was approximately the same, (14 to 15 dB) for the "noisy" and "quiet" locations. The data in Fig. 2 show, in this case, a much greater decrease in reading scores for the 6th grade classes than for the 3rd-grade classes. This is a more prominent effect of grade differences in scholastic effects of noise than was shown by the Bronzaft data.[14, 15] The explanation for this pattern is still uncertain - either differences in teaching style between grades or cumulative compounded effects of poor acoustics on learning still seem to offer plausible explanations. If it were the latter, however, the loss to the learning process would be more critical. Carefully executed prospective educational research studies may be needed to resolve this enigma. It is not just an academic question to be resolved since it has significant implications for placing priorities on improving classroom acoustics at various grade levels.

Not addressed in this paper is the more insidious effect on scholastic achievement that has been attributed to poor classroom acoustics - the tendency for students who can't hear a teacher's instructions to withdraw from active participation in class activity and potentially develop a decreased sense of self-worth.[12]

Other research, including unpublished anecdotal studies, have linked aircraft noise with delayed language acquisition, reading deficiencies, reduced motivation, and long-term recall of learned material. Aside from reduced speech intelligibility, little data were found to gauge the impact on learning achievement from heating, ventilating, and air conditioning noise or from the noise of students interacting in cooperative learning. This seems to be another fruitful area for study.

One other study on classroom acoustics worthy of note for this paper is the recent work carried at Heriot-Watt University in Scotland.[17] Sixty teaching spaces in 13 schools at various locations around the United Kingdom were evaluated for their acoustic environment and corresponding speech communication conditions and teacher satisfaction. The average A-weighted background noise level in the unoccupied classrooms, before any acoustic treatment was applied was 45 dB, identical to the average cited earlier for the sample of US schools. After acoustic treatment, consisting of the application of acoustic absorption materials on the ceiling, the unoccupied background noise levels dropped to 40 dB, presumably reflecting the decrease in the reverberant level with added acoustic absorption. The average reverberation in the unoccupied room dropped, after treatment, from 0.7 seconds to 0.4. While no testing of student achievement was carried out, predictions of improved speech intelligibility demonstrated the effectiveness of the acoustic treatment. As stated by the researchers: "subjectively, classrooms with acoustic treatment were favored by the teachers and pupils, who reported a greater ease of communication and increased performance."[17]

SUMMARY

Limited data strongly indicate that poor classroom acoustics in the form of excessive background noise are indeed barriers to learning, as demonstrated by reduced scholastic achievement. The vital necessity of maintaining a proper acoustic environment while students are acquiring language skills seems especially significant and self-evident.

Further research is called for to more accurately define the magnitude of this degradation in learning and to more clearly define the various confounding factors, especially the potential significance of cumulative loses in learning over time as a child progresses through a school with less than an optimum acoustic environment. Having said that, the existing evidence for adverse effects on learning of poor classroom acoustics provides ample motivation to press on as rapidly as possible to improve the acoustic environment in classrooms and eliminate the acoustic barriers to learning.

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Do School Facilities Affect Academic Outcomes?

National Clearinghouse for Educational Facilities

Mark Schneider
November 2002

On any given school day, about twenty percent of Americans spend time in a school building. The average age of our schools is close to fifty years, and studies by the U.S. General Accounting Office have documented widespread physical deficiencies in many of them. Faced with an aging building stock and growing, shifting student enrollments, states and communities are working hard to build and modernize K–12 facilities.

Those involved in school planning and design see this as an opportunity to enhance academic outcomes by creating better learning environments. Their logic is compelling—how can we expect students to perform at high levels in school buildings that are substandard?

We all know that clean, quiet, safe, comfortable, and healthy environments are an important component of successful teaching and learning. But which facility attributes affect academic outcomes the most and in what manner and degree?

A growing body of research addresses these questions. Some of it is good, some less so; much of it is inconclusive. The research is examined here in six categories: indoor air quality, ventilation, and thermal comfort; lighting; acoustics; building age and quality; school size; and class size.

Indoor Air Quality, Ventilation, and Thermal Comfort

There is a growing body of work linking educational achievement and student performance to the quality of air they breathe in schools. Some of this research is just beginning to make a cumulative mark, and some of the research, for example on thermal comfort, shows how much variation there is between individuals, making guidance for school construction somewhat difficult.

Indoor Air Quality

Poor indoor air quality (IAQ) is widespread, and its effects are too important to ignore. The U.S. General Accounting Office has found that fifteen thousand schools suffer from poor IAQ, affecting more than eight million children or one in five children in America's schools (General Accounting Office 1995). The IAQ symptoms identified—irritated eyes, nose and throat, upper respiratory infections, nausea, dizziness, headaches and fatigue, or sleepiness—have collectively been referred to as "sick building syndrome" (EPA 2000).

Ironically, the high incidence of symptoms stemming from poor IAQ seems to have emerged as an unintended consequence of the electric power brownouts, oil embargoes, and gas lines that characterized the 1970s energy crisis. In response to that national emergency, many buildings, including schools, were fitted with air handling systems and controls that delivered less fresh air than now is considered adequate. Most recommendations from the Occupational Safety and Health Administration (OSHA) and the National Institute of Occupational Safety and Health (NIOSH) now call for between fifteen and twenty cubic feet of air per minute per person. These enhanced ventilation rates not only deliver more adequate supplies of fresh air but also help dilute or remove contaminants, especially chemical (e.g., formaldehyde, toluene, and styrene) and biological (e.g., mold and bacteria) contaminants that have highly demonstrable negative health effects.

Linking IAQ to Student Performance

Most discussions linking IAQ to student performance depend on a series of simple logical links: poor indoor air quality makes teachers and students sick—and sick students and teachers can't perform as well as healthy ones (EPA 2000, Kennedy 2001, Leach 1997). This logic seems unassailable, and researchers are developing the scientific evidence to support it.

Most notably, poor IAQ has been associated with increased student absenteeism. For example, Smedje and Norback (1999) found a positive relationship between airborne bacteria and mold and asthma in children, which in turn increased absentee rates (also Rosen and Richardson 1999, EPA 2000). Further, the American Lung Association (ALA) found that American children miss more than ten million school days each year because of asthma exacerbated by poor IAQ (ALA 2002, EPA 2000).

Rosen and Richardson (1999) found that improving air quality through electrostatic air cleaning technology reduces absenteeism. Their experiment, conducted in two Swedish day-care centers, one old and the other modern, collected data on absenteeism and air quality over three years. The air cleaning technology was operational during only the second of the three test years, and absenteeism fell during that period in both schools. But only in the older school did the change reach statistical significance (absenteeism dropped from 8.31 percent in year one to 3.75 percent in year two, but upon removing the air cleaners, the rate increased to 7.94 percent in year three).

Temperature and Humidity

Temperature and humidity affect IAQ in many ways, perhaps most significantly because their levels can promote or inhibit the presence of bacteria and mold. For example, a study of Florida classrooms with relative humidity levels greater than seventy-two percent found visible mold growth on the ceilings and complaints of allergy symptoms associated with sick building syndrome (Bates 1996). At the other end of the humidity scale, Leach (1997) reported findings of a 1970 study done in Saskatoon, Saskatchewan, Canada, which found absenteeism was reduced in schools by twenty percent as relative humidity in the facilities was increased from twenty-two to thirty-five percent. Wyon (1991) showed that student performance at mental tasks is affected by changes in temperature, and Fang et al. (1998) found that office workers are most comfortable in the low end of temperature and humidity comfort zones. These findings support the idea that students will perform mental tasks best in rooms kept at moderate humidity levels (forty to seventy percent) and moderate temperatures in the range of sixty-eight to seventy-four degrees Fahrenheit (Harner 1974, Wyon, Andersen, and Lundqvist 1979).

Ventilation Effects on Performance

It seems obvious that in a sealed space, without the availability of fresh air from outside, the occupants of that space will die from asphyxiation. Yet despite this knowledge, deaths of workers in confined spaces constitute a recurring occupational tragedy (NIOSH 1986). While we certainly seek to avoid such extreme conditions in schools, a surprising number of classrooms lack adequate ventilation, and evidence is accumulating to support the common-sense notion that occupants of a classroom without good ventilation can't function normally and can't learn at their full capacity.

The purpose of ventilating classrooms and school buildings, at minimum, is to remove or otherwise dilute contaminants that can build up inside. Such contaminants come from people breathing, from their skin, clothes, perfumes, shampoos, deodorants, from building materials and cleaning agents, pathogens, and from a host of other agents that, in sufficient concentrations, are harmful.

Schools need especially good ventilation because children breathe a greater volume of air in proportion to their body weight than adults do (Kennedy 2001, McGovern 1998, Moore 1998) and because schools have much less floor space per person than found in most office buildings (Crawford 1998). But because of the high costs of conditioning the ventilation air in schools to comfortable temperatures before it is circulated, the designers and operators of school buildings can be the unwitting architects of learning spaces that impair learning and health by offering inadequate ventilation—whether this results from economic measures, ignorance, neglect, poor maintenance, or some combination of these factors.

One of the first symptoms of poor ventilation in a building is a buildup of carbon dioxide caused by human respiration. When carbon dioxide levels reach 1000 parts per million (about three times what is normally found in the atmosphere), headaches, drowsiness, and the inability to concentrate ensue. Myhrvold et al. (1996) found that increased carbon dioxide levels in classrooms owing to poor ventilation decreased student performance on concentration tests and increased students' complaints of health problems as compared to classes with lower carbon dioxide levels. The study was conducted at eight different European schools on more than 800 students with results that achieved statistical significance.

Despite the clear need for fresh air in schools, the systems that are the principal source of ventilation other than windows don't always deliver adequate supplies of fresh air. These include not just the ducted systems influenced by the 1970s energy crisis, which often delivered only about one third of the fresh air supplies now deemed adequate (ASHRAE 1989), but a whole variety of ventilation systems with their own unique problems. For example, the through-wall unit ventilators specified in school designs for decades, which connect directly through the wall to an outside air source and are fitted with a fan to draw outside air into the classroom (Strickland 2001), often become shelves for books and other classroom materials, which in turn restricts fresh air flow. The intake vents in these systems, through poor design, siting or neglect, can restrict airflow or can have their flows restricted by snow or debris at ground level, for example, which can result in an accumulation of mold, bacteria, and other contaminants (Crawford 1998). These unit ventilators, beyond creating excessive, sustained background noise that can hinder learning, also tend to filter out less air pollution than more modern ventilation systems, which can lead to higher levels of volatile organic compounds (VOC) in the air (Strickland 2001, 364).

Inadequate ventilation is often a cause of IAQ problems. A 1989 study by the National Institute for Occupational Safety and Health found that more than half of the IAQ problems in the workplace were caused by inadequate ventilation (NIOSH 1989). A 1992 study by Armstrong Laboratory found that the two greatest causes of poor IAQ were inadequate maintenance of heating, ventilation, and air conditioning (HVAC) systems and a lack of fresh air. A 1998 Cornell University study found that workers in poorly ventilated offices are twice as likely to report the symptoms of sick building syndrome as employees in well-ventilated environments. The study also found that a relatively small buildup of carbon dioxide from human respiration—an indicator of poor ventilation—is also related to sick building syndrome (Lang 1998).

In a recent study, twenty-six percent of Chicago public school teachers and more than thirty percent of Washington, D.C., teachers interviewed reported health-related problems caused by the school facility. Most of these problems were related to poor indoor air quality, with teachers reporting that asthma and other respiratory problems were the main adverse health effect (Schneider 2002).

As for scientific evidence for ventilation's effect on performance, two recent papers examining talk times for registered nurses in call centers found that ventilation levels had only a small negative effect on productivity (Federspiel et al. 2002, Fisk et al. 2002). However, Smedje and Norback (1999) and Wargocki et al. (1999) reported stronger links. Wargocki et al. found that ventilation levels in offices affected performance in logical reasoning, typing, and arithmetic (also EPA 2000). The researchers also found that higher carbon dioxide levels increased the incidence of headaches, which appeared "to affect human performance during office work by reducing the inclination to exert effort" (Wargocki et al. 1999, 136). Can we assume that this relationship might extend to students, perhaps even more so because they are growing, developing, and attempting to learn new things?

Smedje and Norback (1999) in a 1993 survey found that students with asthmatic symptoms were less likely to report them two years later if the school they attended had installed a new ventilation system in the meantime. Given that asthma is among the leading causes of absenteeism in American schools, we can assume that improved ventilation can bring about less asthma, better school attendance, and improved academic performance.

Walinder et al. (1997) found that schools in Sweden with the lowest ventilation rates had VOC concentrations two to eight times higher than schools with adequate ventilation, and students in these schools were more likely to have swelling of the nasal mucosa, a symptom associated with sick building syndrome that could lead to absenteeism.

Though we know that some specific components of indoor air quality will likely affect students, rigorous studies comparing the individual effects and the interactive effects of different aspects of air quality still are needed. As Woods et al. note, “Building managers and other fiscal decision-makers still tend to minimize the value of environmental control. This may be in part caused by the absence of scientific, quantifiable data to support decisions addressing health impacts.” Woods also argues that most previous field studies have not had adequate control groups, and many studies have been anecdotal. Moreover, most studies have focused on single environmental media, leaving aside the critical issue of interaction effects between daylighting, air quality, noise, thermal comfort, or other factors that affect learning (Woods et al., no date, 1–2).

Given these problems, it is perhaps not surprising that the American Public Health Association (2000) has criticized the U.S. Department of Education for the lack of scientific research in this area.

There may be some improvements in the state of knowledge in the future. One promising study is a three-year research project launched in 2001 by the HP-Woods Research Institute. Based on a rigorous research design with treatment and control groups, the study is to focus on student performance, health, and productivity (improved performance compared to the cost of creating that performance) at differing levels of IAQ and with different mechanisms in place for solving IAQ problems. The study is intended to follow third and fourth graders in six schools from two areas in Montgomery County, Maryland.

The Center for the Built Environment (CBE) at the University of California at Berkeley has placed ventilation's effects on productivity on its research agenda, so perhaps it will find new scientific evidence that will yield better assessments of ventilation's effects on student performance.

The federal government may act as a catalyst for more research. The No Child Left Behind Act of 2001 calls for more research into IAQ and student performance. Specifically, Section 5414 of the bill calls for the Department of Education to conduct a “study regarding the health and learning impacts of environmentally unhealthy public school buildings on students and teachers” (U.S. Congress 2002). The bill goes further, requesting that the Department of Education make recommendations to Congress on how to bring schools into compliance with environmental health standards and the cost of such an effort. While no date exists determining when such a study takes place, it should eventually provide much needed guidance for policy makers.

The current lack of specific knowledge makes it difficult for policy makers to create definitive IAQ standards. However, while scientists, engineers, architects, and others seek to quantify more exactly the precise links between IAQ and student performance, some school districts are investing extra effort and resources to ensure that fresh air in schools is plentiful and readily available to students and teachers. Minneapolis schools—where the design and construction of school buildings is managed to maximize air quality—are a case in point (Leach 1997, 32). The list of such “demonstration” projects is expanding. Indeed, there is a growing movement to construct schools that provide not only good indoor air quality and thermal comfort but also utilize high-performance energy-saving HVAC systems coupled to other advanced building systems, including environmentally preferable building materials and products in order to produce quality schools that promote rather than detract from the health and productivity of occupants over their life (SBIC 2000).

IAQ and Environmental Justice

As with several other areas reported in this publication linking the quality of school facilities to student performance, some researchers are directly concerned about the disproportionate effect of poor air quality in schools on students from racial minority groups and from families having lower socio-economic status.

Most notably, the Children's Environmental Health Network's (CEHN) 1997 conference on the exposure of children to environmental hazards reported that children from racial minorities are more likely to encounter poor IAQ. The proceedings of the CEHN conference stated that Black and Hispanic neighborhoods have a disproportionate number of toxic waste facilities in their neighborhoods and that eighty percent of Hispanics live in neighborhoods where air quality does not meet EPA standards (CEHN 1997). While this finding does not specifically focus on schools, the existence of poor quality air in these neighborhoods may parallel poor quality air indoors in schools.

Statistics from the General Accounting Office report on school facilities in 1996 directly confirm that schools serving poor and minority students do suffer disproportionately from poor IAQ (General Accounting Office 1996). Of schools where less than forty percent of their students were eligible for free lunch, approximately sixteen percent reported unsatisfactory IAQ, but of schools where more than forty percent of students were eligible for free or reduced-cost lunch, almost twenty-three percent reported having unsatisfactory IAQ. Similarly, fewer than eighteen percent of schools with less than twenty and one-half percent minority students reported unsatisfactory IAQ. In contrast, more than twenty percent of schools with minority populations between twenty and one-half percent and fifty and one-half percent reported unsatisfactory IAQ, and almost twenty-three percent of schools with minority populations greater than fifty and one-half percent reported unsatisfactory IAQ.

"Teachers seemed to hold a basic expectation that they would be able to control light levels, sun penetration, acoustic conditions, temperature, and ventilation in their classrooms."

As with so many other issues linking school facilities to educational outcomes, the demands of environmental justice and social justice overlap to call attention to the disproportionate burden that poor and minority students carry in education.

Thermal Comfort

Researchers have been studying the temperature range associated with better learning for several decades. Harner (1974) found that the best temperature range for learning reading and math is sixty-eight to seventy-four degrees Fahrenheit and that the ability to learn these subjects is adversely affected by temperatures above seventy-four degrees Fahrenheit. As temperature and humidity increase, students report greater discomfort, and their achievement and task-performance deteriorate as attention spans decrease (King and Marans 1979). McGuffey (1982) was one of the first to synthesize existing work linking heating and air conditioning to learning conditions, and her work still is widely cited.

Research also shows that even within commonly acceptable temperature spans, there are specific ranges that increase individual performance. It is not feasible, however, to provide every student in a common space with the temperature or humidity that best suits him or her.

Thermal factors may seriously degrade teachers' abilities to teach and may also affect their morale. In the 2002 follow-up study to the school daylighting study completed in 1999 by the Heschong Mahone Group, environmental control was found to be an important issue for teachers, especially for those who lacked full environmental control:

> Teachers seemed to hold a basic expectation that they would be able to control light levels, sun penetration, acoustic conditions, temperature, and ventilation in their classrooms. They made passionate comments about the need for improvement if one or more of the environmental conditions could not be controlled in their classrooms (Heschong 2002).

Lowe (1990) found that the best teachers in the country emphasized their ability to control classroom temperature as central to the performance of teachers and students. Lackney (1999) showed that teachers believe thermal comfort affects both teaching quality and student achievement. Corcoran et al. (1988) focused on how school facilities' physical conditions affect teacher morale and effectiveness. They conclude that problems caused by working conditions may result in higher absenteeism, reduced effort, lower effectiveness in the classroom, low morale, and reduced job satisfaction.

Lighting

Classroom lighting plays a particularly critical role in student performance (Phillips 1997). Obviously, students cannot study unless lighting is adequate, and there have been many studies reporting optimal lighting levels (see Mayron et al. 1974, Dunn et al. 1985, 866). Jago and Tanner's review (1999) cites results of seventeen studies from the mid-1930s to 1997. The consensus of these studies is that appropriate lighting improves test scores, reduces off-task behavior, and plays a significant role in students' achievement.

Recently there has been renewed interest in increasing natural daylight in school buildings. Until the 1950s, natural light was the predominant means of illuminating most school spaces, but as electric power costs declined, so too did the amount of daylighting used in schools. According to Benya, a lighting designer and consultant, recent changes, including energy-efficient windows and skylights and a renewed recognition of the positive psychological and physiological effects of daylighting, have heightened interest in increasing natural daylight in schools (Benya 2001).

Lemasters' (1997) synthesis of fifty-three studies pertaining to school facilities, student achievement, and student behavior reports that daylight fosters higher student achievement. The study by the Heschong Mahone Group (1999), covering more than 2000 classrooms in three school districts, is perhaps the most cited evidence about the effects of daylight. The study indicated that students with the most classroom daylight progressed twenty percent faster in one year on math tests and twenty-six percent faster on reading tests than those students who learned in environments that received the least amount of natural light (also Plympton, Conway, and Epstein 2000). There were some questions that could not be answered by the original Heschong study, such as whether the higher performance was driven at least in part by better teachers being assigned to the classrooms that received more daylight. A follow-up study surveyed teachers in one of the districts and added information on teacher characteristics to the analysis. This new report found that the effect of daylighting remained both positive and significant. Other studies are currently in process to try to validate the results in another school district and determine more detail about a possible mechanism for such an effect.

While the scientific foundation linking daylighting to learning is accumulating, there have been distractions and fads that affect school lighting decisions. For example, there has been an ongoing controversy about so-called "full-spectrum" fluorescent lighting, and some schools have been re-lamped at considerable expense to offer this perceived benefit (the lamps themselves are several times more expensive than conventional lamps and produce significantly less light). But according to Gifford, research on the effects of full-spectrum lighting has been "inexpert" (Gifford 1994, 37), and the strong claims made about such lighting have been based on poor research that does not meet even rudimentary standards of scientific investigation. Indeed, in 1986, the U.S. Food and Drug Administration instructed the Duro Test Corporation, makers of Vita-lite and promoters of UV enhanced "full-spectrum" lamps, to cease and desist from making claims about any health benefits from non-clinical applications of this type of light source (Benya 2001, Gifford 1994).

While there are serious questions about the effects of full-spectrum fluorescent lighting, there is sufficient reason to believe that daylight provides the best lighting conditions.

There also have been studies attempting to correlate elements such as color and aesthetic appeal with student achievement. One example is Cash's report (1993) that student achievement improved when walls were painted pastel colors instead of white. The appeal of physical conditions such as color may vary considerably among individuals, and there is a good opportunity here for further work with definitive recommendations.

Acoustics

The research linking acoustics to learning is consistent and convincing: good acoustics are fundamental to good academic performance.

In one of their many syntheses of existing work, Earthman and Lemasters (1998) reported three key findings: that higher student achievement is associated with schools that have less external noise, that outside noise causes increased student dissatisfaction with their classrooms, and that excessive noise causes stress in students (1998, 18).

Crandell et al. (1995) and Nabelek and Nabelek (1994) reviewed the literature linking the acoustical environment in a classroom to the academic achievement of children and have linked levels of classroom noise and reverberation to reading and spelling ability, behavior, attention, concentration, and academic achievement in children (also ASHA 1995, Crandell 1991, Crandell and Bess 1986, and Crandell et al. 1995). Evans and Maxwell (1999) examined 100 students enrolled in two New York City schools, one of which was in the flight path of an airport. The students exposed to the air-traffic noise scored as much as twenty percent lower on a reading test than children in the other school.

There also is evidence of a cumulative effect of excessive classroom noise on a child's academic achievement level. These problems are more acute for children who may have hearing impediments and may affect the detection of such impediments (Nelson and Soli 2000). It also is generally agreed (Fisher 2000) that high noise levels cause stress. Noise levels influence verbal interaction, reading comprehension, blood pressure, and cognitive task success and may induce feelings of helplessness, inability to concentrate, and lack of extended application to learning tasks.

Teachers attach importance to noise levels in classrooms and schools. Lackney (1999) found that teachers believe that noise impairs academic performance. Indeed, it appears that external noise causes more discomfort and lowered efficiency for teachers than for students (Lucas 1981). This factor could lower the quality of teaching and, ultimately, learning.

Clearly, classroom acoustics matter, and yet Feth and Whitelaw (1999) found that the acoustics of many classrooms are poor enough to make listening and learning difficult for children. Their study of thirty-two classrooms in central Ohio primary schools found that only two met the standards recommended by the American Speech-Language-Hearing Association (ASHA).

Other studies cite acoustics problems in schools. For example, a third of the school systems cited in a 1995 General Accounting Office study reported that poor acoustics were their most serious environmental concern (General Accounting Office 1995). Studies of elementary and secondary school classrooms revealed that excessive background noise, which competes with the speech of teachers, aides, classmates, and audio-educational media, is common even in new classrooms (U.S. Architectural and Transportation Barriers Compliance Board 1999).

Acoustical performance is an important consideration in the design of classrooms, according to the U.S. Architectural and Transportation Barriers Compliance Board (2002), an independent federal agency devoted to accessibility for people with disabilities. The board writes:

> Research indicates that high levels of background noise, much of it from heating and cooling systems, adversely affect learning environments, particularly for young children, who require optimal conditions for hearing and comprehension. Poor acoustics are a particular barrier to children with a hearing loss. For the past several years, the Board has worked with the private sector in the development of classroom acoustics standards as an alternative to rulemaking of its own. In 1999, the Board partnered with the Acoustical Society of America (ASA) on the development of a new standard for acoustics in classrooms that takes into account children who are hard of hearing. The standard, completed in 2002, has been approved as ANSI/ASA S12.60-2002, Acoustical Performance Criteria, Design Requirements and Guidelines for Schools. It sets specific criteria for maximum background noise (thirty-five decibels) and reverberation (0.6 to 0.7 seconds for unoccupied classrooms). These and other specifications are consistent with long-standing recommendations for good practice in acoustical design.

When these standards are implemented, schools may face significant costs. For example, many existing HVAC systems, particularly room unit ventilators, will exceed these noise standards.

While science is clearly linking daylighting, acoustics, and indoor air quality to learning outcomes, it is harder to scientifically measure the effects on learning of such factors as building quality and size or the way that a building may be divided into different learning spaces and different-sized classrooms. Almost all the other research discussed here so far is fairly tightly focused on single environmental (or closely related) factors, and many of the conditions can be directly measured (including decibel levels, air flows, lumens, and so on). However, when we begin to look at the effects of more complex variables, such as the overall quality of school buildings, school size, or class size, we immediately see that these factors or "inputs" are multitudinous and multidimensional—making it much harder to identify and isolate precise measures and effects. The outcomes also are harder to isolate and measure accurately, although over the past twenty years, standardized test scores have been a principal measure of learning outcomes. And in much of this work discussed below, higher test scores have become the holy grail of facilities reform.

Building Age, Quality, and Aesthetics

McGuffey's 1982 synthesis of earlier studies correlated student achievement with better building quality, newer school buildings, better lighting, better thermal comfort and air quality, and more advanced laboratories and libraries. More recent reviews by Earthman and Lemasters (1996, 1998) report similar links between building quality and higher test scores. For example, researchers studying Georgia's primary schools found that fourth-grade students in non-modernized buildings scored lower in basic skills assessments than students in modernized or new buildings (Plumley 1978). Similarly, Chan (1979) found that eighth-grade students scored consistently higher across a range of standardized tests if housed in new or modernized buildings. Bowers and Burkett (1987) found that students in newer buildings outperformed students in older ones and posted better records for health, attendance, and discipline. The study attributed approximately three percent of the variance in achievement scores to facility age, after considering socio-economic differences in the student populations. In more recent work, Phillips (1997) found similar improvements in newer facilities, and Jago and Tanner (1999) also found links between building age and student achievement and behavior.

Clearly, there is consensus that newer and better school buildings contribute to higher student scores on standardized tests (Plumley 1978; Edwards 1992; Cash 1993; Earthman and Lemasters 1998; Hines 1996), but just how much varies depending on the study and the subject area. For example, Phillips (1997) found impressive gains in math scores, but Edwards (1992) found much lower gains in social sciences.

Isolating the independent effects of age and building condition is essential to studies such as these but may be difficult to do; a building's age can be ascertained from public records, but its condition is harder to gauge. Building quality actually may have less to do with age and more to do with the budget for that particular building. In older buildings, a lack of maintenance can ruin an otherwise high-quality building; in new buildings, funding limitations can result in a brand new building of inferior quality. Any careful study must account for these factors.

Indeed, some researchers have tried to rigorously identify the effect of building quality independent of building age. Andersen (1999) studied the relationship of thirty-eight middle-school design elements to student scores from twenty-two schools on the Iowa Test of Basic Skills and found positive correlations with twenty-seven elements. Maxwell (1999) found a correlation between newer facilities and student performance levels and a significant relationship between upgraded facilities and higher math scores. But her study also found lower student performance during the renovation process, since classes can be disrupted during renovation. In at least one case (Claus and Girrbach 1985), reading and math scores improved among the better students when buildings were renovated, but the scores fell among the lowest-performing students.

Lewis (2000) tried to identify the independent effects of school quality in a study of test scores from 139 schools in Milwaukee and found that good facilities had a major impact on learning.

Stricherz (2000) notes that student achievement lags in inadequate school buildings but suggests there is no hard evidence to prove that student performance rises when facilities improve well beyond the norm. "Research does show that student achievement lags in shabby school buildings—those with no science labs, inadequate ventilation, and faulty heating systems," Stricherz says. "But it does not show that student performance rises when facilities go from the equivalent of a Ford to a Ferrari—from decent buildings to those equipped with fancy classrooms, swimming pools, television-production studios, and the like."

While many studies link the effects of building quality to academic achievement, other studies tie building quality to student behavior. Vandalism, leaving early, absenteeism, suspensions, expulsions, disciplinary incidents, violence, disruption in class, tardiness, racial incidents, and smoking all have been used as variables in these studies.

More than sixteen studies collated by McGuffey (1982) found fewer disciplinary incidents as building quality improved. Discipline also was better in newer buildings. However, later reports (Edwards 1992; Cash 1993) found that disciplinary incidents actually increased in schools with newer and better buildings—perhaps caused by the stricter discipline standards in these newer schools, among other factors.

In studying how school quality relates to achievement and behavior, the criteria that Earthman et al. (1995) used included factors such as structural differences and open space as indicators of quality. They found that schools farther up the overall quality index had fewer disciplinary incidents, but schools that rated higher only on the structural component had more disciplinary incidents.

A recent study in Great Britain by Pricewaterhouse-Coopers (2001) linked capital investment to academic achievement and other outcomes such as teacher motivation, school leadership, and student time spent on learning. This study combined quantitative and qualitative analysis and was based on interviews with teachers and headmasters. Its quantitative analysis found weak and inconsistent relationships between capital expenditures and outcomes. However, the study's surveys found a stronger link between capital expenditures and motivation and leadership. The researchers concluded (p. 42):

- Good teaching takes place in schools with a good physical environment;
- Good school leadership can also be found in schools with a high-quality capital stock;
- The general attitudes, behavior, and relationships amongst pupils and staff are more conducive to learning in those schools which have had significant capital investments.

A careful look at the data reported by Pricewaterhouse-Coopers shows some weaknesses in the study. For example, most of the data collected by Pricewaterhouse-Coopers was used in an econometric production function analysis. As with virtually all such studies, the analysis found few, if any, relationships linking capital spending and academic achievement. The study's organizers then turned to interviews and other more impressionistic data upon which to base their findings. But the data they collected were not particularly useful in helping policy makers decide how to allocate monies across different categories of expenses. For example, no one would be able to know from the study whether it would be better to invest in improved air quality or to ensure that classrooms met certain acoustics standards.

While existing studies on school building quality basically point to improved student behavior and better teaching in higher-quality facilities, what is needed is more firm policy advice about the types of capital investments that would be most conducive to learning and to good teaching. This would help those who manage construction dollars better target and maximize the return on such investments.

School Size

Schools in the United States have grown larger and larger, but how this growth affects learning is still being explored. Buildings housing two or three thousand students are not uncommon; high schools in some large cities house five thousand students (Henderson and Raywid 1994). The trend toward large schools stems from several historical processes, including school district consolidation and the belief that large schools can deliver education with major economies of scale. As a result of rural school district consolidation and lack of available sites and population growth in central cities, large schools began appearing in this country as early as 1869. The post-WWII baby boom and concurrent population shift from city to suburbs made larger schools commonplace.

These trends accelerated as a result of the Cold War. When Sputnik was launched in 1957, so too was our nation's desire to quickly graduate scientists to meet that perceived challenge. Close on Sputnik's heels came Conant's 1959 book, *The American High School Today*, calling the small high school America's number one education problem and suggesting its elimination be a top priority (Conant 1959, 37–38).

Although what Conant considered an appropriate size for schools was not that large by today's standards, his book became part of a school facilities planning mentality that saw larger and larger schools constructed routinely. And these newer, larger schools often have been sited away from neighborhoods.

"A specific benefit associated with smaller schools is higher student achievement, an especially significant outcome given the importance now accorded to test scores."

Today, ironically, despite the need for more classrooms because of renewed enrollment growth, many neighborhoods face losing their schools because of declining enrollments or school consolidation. According to estimates of the Building Education Success Together team (BEST), nearly 200 schools in Chicago, Cleveland, Columbus, Cincinnati, and Washington, D.C., may be closed or consolidated because they have smaller student populations than they were originally designed for (BEST 2002). Yet this decision is being made even while evidence accumulates that small schools may work better than large ones, especially for students with lower socio-economic status. Indeed, there's an impressive body of literature linking small school size to positive outcomes. This literature is worth studying—but with three caveats:

First, while the evidence affirms small is generally better, the definition of small varies across studies. At one level there is the question about whether or not policy makers should be aiming to create schools of some specific size. In contrast, many studies are looking at the effects of size as a "continuous" variable. There is some evidence that no matter the size distribution, the smaller schools in the distribution enhance achievement (Howley, Strange, and Bickel 1999). This finding implies that a policy of smaller size, no matter the starting point, and notwithstanding any absolute definition of smallness, is appropriate. And as shown below, this may be especially true in low-income communities. But despite the possibility that any reduction in size is good, the consensus seems to be that small-school benefits are achieved in the 300- to 400-student range for elementary schools and less than 1,000 students for high schools (Cotton 1996).

Second, the evidence on various reforms to create small schools through mechanisms such as schools-within-schools, where large schools are subdivided into "houses" or "academies," is nowhere near as extensive or conclusive as the evidence on school size. This is partly because these reforms are relatively new and partly because arrangements that create schools within a school vary so widely. Cotton (2001) has produced perhaps the best review of what we currently know about these arrangements to create more intimate learning places.

Third, much of the work linking school size to education outcomes derives from case studies and other less quantitative evidence. While the evidence calls for small schools, specific findings will need to withstand stronger scrutiny.

With these caveats in mind, there is a growing body of research linking smaller school size to higher student achievement. In one of the earliest studies, Barker and Gump (1964) used sophisticated sociological concepts and measurements to link the size of a school as an "ecological environment" to the behavior of individual students.

> The large school has authority: its grand exterior dimensions, its long halls and myriad rooms, and its tides of students all carry an implication of power and rightness. The small school lacks such certainty: its modest building, its short halls and few rooms, and its students, who move more in trickles than in tides, give an impression of casual

> or not quite decisive educational environment (p. 195).

Barker and Gump conclude that these outside "views" are wrong and that there are strong forces within small schools that create, stimulate, and even compel students to become more active and involved with school events and learning than in large schools. The authors concentrated on extra-curricular activities and found that the proportion of students engaged in these activities was as much as twenty times higher in the four small schools they studied compared to the largest one. More students in the smaller schools were involved in a wider range of activities, and many more students held leadership positions than in the largest schools. And the students in the smaller schools were not only more involved but more satisfied with their experiences (ch. 12).

Barker and Gump were among the first to demonstrate diminishing returns to increasing school size. While they recognized that big schools may be able to provide some services that small schools cannot, ultimately they concluded that: "It may be easier to bring specialized and varied behavior settings to small schools than to raise the level of individual participation in large schools" (p. 201).

The soundness of these observations has withstood the test of many newer studies. In one recent and well-known study linking school size to beneficial outcomes, Wasley et al. (2000) argue that small schools can:

- improve education by creating small, intimate learning communities where students are well-known and can be encouraged by adults who care for them and about them,
- reduce isolation that adversely affects many students,
- reduce discrepancies in the achievement gap that plagues poor children, and
- encourage teachers to use their intelligence and skills.

In addition, small schools often encourage parental involvement, which benefits students and the entire community (Schneider et al. 2000).

Nathan and Febey (2001) identify similar beneficial outcomes. In their highly regarded study, "Smaller, Safer, Saner, Successful Schools," they argue that smaller schools, on average, can provide:

- a safer place for students,
- a more positive, challenging environment,
- higher achievement,
- higher graduation rates,
- fewer discipline problems, and
- greater satisfaction for families, students, and teachers.

Raywid (1999) aptly summarizes the value of small schools. She says that students in these schools "make more rapid progress toward graduation, are more satisfied with small schools, fewer of them drop out than from larger schools, and they behave better in small schools." Indeed, Raywid concludes that: "All of these things we have confirmed with a clarity and at a level of confidence rare in the annals of education research." (Also see Howley 1994, Irmsher 1997, and Cotton 1996, 2001.)

A specific benefit associated with smaller schools is higher student achievement, an especially significant outcome given the importance now accorded to test scores. Fowler and Walberg (1991) found that school size was the best predictor of higher test scores in 293 New Jersey secondary schools, even considering widely varying socio-economic factors. Lee and Smith (1997) using the National Educational Longitudinal Study linked school size with higher performance, and Keller (2000) showed that small schools consistently outperformed large ones, based on evidence from 13,000 schools in Georgia, Montana, Ohio, and Texas (also Duke and Trautvetter 2001). There is considerable evidence on this point contained in reviews by Howley, Cotton, and Raywid. Here's how Cotton (1996) summarizes her reading of existing studies:

> About half the student achievement research finds no difference between the achievement levels of students in large and small schools, including small alternative schools. The other half finds student achievement in small schools to be superior to that in large schools. None of the research finds large schools superior to small schools in

> their achievement effects. Consequently, we may safely say that student achievement in small schools is at least equal—and often superior—to student achievement in large schools.

Achievement measures used in the research include school grades, test scores, honor roll membership, subject area achievement, and assessment of higher-order thinking skills.

Perhaps there is even stronger evidence linking the effects of small school size and higher performance in communities having low socio-economic status. Pertinent findings often stem from the Matthew Project, inspired by the 1988 work of Friedkin and Necochea, who presented empirical evidence linking smaller schools with stronger academic performance in impoverished communities. Over time, Friedkin's and Necochea's findings have been replicated in studies conducted in school districts in Arkansas, Georgia, Ohio, Montana, Texas, and West Virginia, and in districts in California other than those Friedkin and Necochea studied (see Howley and Bickel 1999, Howley 1995). While specific effects vary from study to study, and while the definition of small varies across studies, the cumulative evidence in these works is that smaller school size leads to higher performance in poor communities.

In general, school size has been tied to other desirable outcomes besides better academic performance.

• **Small schools can reduce violence and disruptive behavior.** Smaller schools seem to reduce negative student behavior, especially among students of low socio-economic status (see especially Gregory 1992, Stockard and Mayberry 1992, and Kershaw and Blank 1993). The research here tends to be more anecdotal, however, based on case studies, and it lacks the quality of work that links school size to achievement.

• **Small schools can improve a wide range of student attitudes and behavior.** Smaller schools seem to reduce the anonymity and isolation that students sometimes experience (Barker and Gump 1964), and they may increase students' sense of belonging. Fowler and Walberg (1991) argue that both large school size and large district size were associated with reductions in participation in school activities, satisfaction, attendance, feelings of belonging, and other measures of school climate (see also Stockard and Mayberry 1992, Foster and Martinez 1985). Small schools also seem to have lower dropout rates (Toenjes 1989, Pittman and Haughwout 1987, Stockard and Mayberry 1992), higher attendance rates (Fowler 1995, Howley 1994), and higher graduation rates (Farber 1998).

• **Small schools can improve teacher attitudes.** There is less research on this point, but most of it links smaller schools to higher levels of cooperation between teachers, better relations with school administrators, and more positive attitudes toward teaching (see Hord 1997, Gottfredson 1985, Stockard and Mayberry 1992). Lee and Loeb (2000) found more positive teacher attitudes in the small schools that planners created in Chicago as part of a city-wide plan to reduce school size.

• **Small schools may be cost effective.** Many studies dispute the often-heard justification for consolidating smaller schools into larger ones based on economies of scale. These works document the absence of economies of scale in public organizations and especially in public organizations that are labor intensive, such as schools. The evidence is fairly conclusive that economies of scale quickly become dis-economies of scale as schools grow in size (Steifel et al. 2000, Gregory 1992, Walberg 1992, Robertson 1995). Indeed, Gregory (1992, 5) writes:

> The perceived limitations in the program that small high schools can deliver, and their presumed high cost, regularly have been cited as justifications for our steady march toward giantism. The research convincingly stamps both of these views as misconceptions.

Not only does the cost of education increase with larger schools, but related research shows that curricula do not improve with increased school size. Indeed, some research indicates that the supposed improvements in curricula associated with school size face rapidly diminishing marginal returns. Pittman and Haughwout (1987, 337) argue that "It takes a lot of bigness to add a little variety."

• **Public opinion data confirm a preference for small schools.** In February 2002, the public opinion research organization Public Agenda released a study endorsing small schools. Based on surveys of parents, teachers, and students, the report notes that more than two-thirds of the parents interviewed believed that smaller high schools offer a better sense of belonging and community, have administrations that would be more able and likely to identify poorly performing teachers, and would be better able to tailor instruction to individual needs. Conversely, two-thirds of the parents interviewed thought that larger schools were more likely to have discipline problems. Based on these findings, Public Agenda (2002, 1) concluded:

> The latest idea in America's ongoing debate on education reform has been a simple one: when it comes to schools, small is beautiful. A group of influential reformers says the U.S. trend toward larger and larger school buildings is creating schools that are difficult to manage in which students feel alienated and anonymous. These advocates call for high schools of around five hundred pupils, saying teenagers thrive in more personal settings. The kind of comfortable, informal communication that takes place readily in a small institution is simply not feasible, these advocates say, in a larger, more harried one.

In their study about what motivated parents to seek vouchers available through the Children's Scholarship Fund, a nationwide privately funded voucher program targeted at low income families, Peterson et al. (2001) argued that, among other reasons parents chose to participate in the program, "Parents applied for vouchers partly in order to shift from the larger schools in the public sector to the smaller schools generally available in the private sector" (p. 16).

Based on the cumulative findings on school size, Ayers et al. (2000) argue that making schools smaller is the "ultimate reform." While this argument certainly would benefit from better research across all these issues and by a more precise definition of small, findings now indicate that reducing school size can produce considerable benefits across a range of outcomes—and there is little evidence showing that reducing school size will produce negative outcomes. This is especially true for children and communities ranked lower in socio-economic status.

Class Size

Class size is an important factor in school design and drives a host of costly facility-related issues that are part and parcel of the school building's planning, design, construction, cost, maintenance, and operation. Given that education is labor intensive, class size is a big factor in determining the number of teachers needed and, hence, how much education will cost. While social scientists are engaged in an intense debate over the effects of class size on educational outcomes, there is widespread popular belief that smaller classes are better.

Of the teachers surveyed by Public Agenda, seventy percent said that small class size is more important to student achievement than small school size. This preference for smaller classes is being codified in law: nearly half the states have enacted legislation and are spending hundreds of millions of dollars each year to reconfigure school buildings to reduce the student-teacher ratio to twenty or fewer students per teacher (National Association of Elementary School Principals 2000).

At the national level, the Clinton administration made class size reduction a centerpiece of its educational reform efforts, and the Bush administration has followed suit. Despite the popularity of small classes, the scientific evidence linking class size to achievement is mixed—and hotly contested.

The Debate Over Class Size

The debate in the literature over class size is often highly technical and focuses on fights over appropriate methods for using metanalysis to identify patterns in existing work. Much of this work has been done by economists focusing on the efficiency of education measured by the effects of different inputs, such as class size, to educational outputs, such as test scores.

One of the leading scholars in this field, Eric Hanushek, believes that educational inputs, including class size, are not associated with higher performance (Hanushek 1997, 1999). The outputs he gauges usually are test scores measured by the National Assessment of Educational Progress (NAEP), a long-term project administered by the National Center for Education Statistics.

(For more information on NAEP see http://nces.ed.gov/nationsreportcard/about/)

Hanushek has collected a set of studies that begin with the Coleman report and run through 1994, and each of these studies includes estimates of how some school factor (such as class size, for example) affects some desired academic output (such as test scores). Equations that link such inputs to outputs are called a production function, and Hanushek's original database consisted of 377 different production function estimates contained in ninety individual publications. According to Hanushek (1997), of these estimates, 277 include some measure of student/teacher ratios (not class size) and of these, only fifteen percent find statistically significant effects showing that lower student/teacher ratios increased performance, while an almost equal number (thirteen percent) report that lower student/teacher ratios reduced test scores. In the handful of studies that have actual measures of class size, the results also are mixed.

"Collectively, the work of Krueger, Greenwald, Hedges, and Laine has undermined the strength of Hanushek's argument—but the issue is far from settled."

In a number of publications, Greenwald, Hedges, and Laine have attacked Hanushek's methodology and findings. A 1996 article in the *Review of Educational Research* sets forth their reasoning. They argue that, based on their analysis of a larger set of production functions than Hanushek used, "A broad range of school inputs are positively related to student outcomes, and that the magnitude of the effects are sufficiently large to suggest that moderate increases in spending may be associated with significant increases in achievement" (Greenwald, Hedges, and Laine 1996, 362).

Similarly, Krueger (2000) argues that Hanushek's findings are based on a flawed methodology. According to Krueger, Hanushek's reported findings are derived by weighting all the studies included in his database equally, thus placing a disproportionate weight on a small number of studies that use small samples and mis-specified models. Krueger argues further that Hanushek exercised "considerable discretion" in applying his own selection rules. According to Krueger, "Hanushek's procedure of extracting estimates assigns more weight to studies with unsystematic or negative results" (p. 10).

Using a different (and easily defended) weighting rule that corrects for the number of results reported in the same study, Krueger shows that studies with positive effects of class size are almost sixty percent more prevalent than studies with negative effects. In a second exploration of the effects of weighting schemes, Krueger weights the studies in Hanushek's database by the quality of the journal in which it appeared (utilizing impact scores calculated by the Institute for Scientific Information based on the average number of citations to articles published in the journals in 1998). Using this weighting method, positive findings again are twice as likely as negative findings.

Hunt (1997, ch. 3) provides more detail on the rather intense arguments that greeted Hanushek's work. Collectively, the work of Krueger, Greenwald, Hedges, and Laine has undermined the strength of Hanushek's argument—but the issue is far from settled.

While Hanushek has been a driving force in staking out the "class size doesn't matter" position, other researchers using a range of data also have found that reducing class size has no effect on educational outcomes. For example, Hoxby (2000), using naturally occurring variation in class sizes in a set of 649 elementary schools, finds that class size has no effect on student achievement. An analysis of the relationship between class size and student achievement for Florida students using 1993–94 school level data found no relationship between smaller classes and student achievement (State of Florida 1998). Similarly, Johnson (2000) finds no effect of class size on 1998 NAEP reading scores, other things being equal. While many studies use student/teacher ratios, Johnson uses class size, and he compares students' performance in classes that have both more and less than twenty students and finds no difference. However, Johnson notes that the range of class sizes in his database may not be sufficient, since some researchers such as Mosteller (1995) and Slavin (1989) find effects only for very large declines in class size.

In contrast, Robinson and Wittebols (1986), using a related cluster analysis approach of more than one hundred relevant research studies (in which similar kinds of research studies are clustered or grouped together), concluded that the clearest evidence of positive effects of smaller class size is in the primary grades, particularly kindergarten through third grade, and that reducing class size is especially promising for disadvantaged and minority students.

More positive conclusions on the influence of class size have been drawn from an analysis of Texas schools. Using data from more than 800 districts containing more than 2.4 million students, Ferguson (1991) found significant relationships among teacher quality, class size, and student achievement. For first through seventh grades, using student/teacher ratio as a measure of class size, Ferguson found that district student achievement fell as the student/teacher ratio increased for every student above an eighteen to one (18:1) ratio.

Other studies find that class size affects test scores (Ferguson 1991, Folger and Breda 1989, Ferguson and Ladd 1996). Wenglinsky (1997) used data from fourth graders in more than 200 districts and eighth graders in 182 districts and found that smaller class size positively affected math scores for fourth graders and improved the social environment for eighth graders, which in turn produced higher achievement. These effects were greatest for students of lower socio-economic status.

None of these econometric studies, however, have shown very large effects, and many researchers caution about the high cost of implementing this reform relative to its expected benefits. While the econometric evidence has been inconclusive, there have been a series of experiments in which class sizes have been reduced, and the results of these experiments have been interpreted to support the benefits of smaller class size.

In Indiana, the Prime Time project reduced class size from approximately twenty-two to nineteen students in first grade and from twenty-one to twenty students in second grade. The study's design drew criticism, which cast doubt on its modest conclusions. Beginning in 1990, Burke County, North Carolina, phased in a class-size reduction project, with the goal of placing all first, second, and third grade students in classes limited to about fifteen students. This project offered a better design, improved experimental criteria, and results that, according to Egelson et al. (1996), increased time on task and decreased disciplinary problems substantially.

“Smaller classes allow more time for instruction and require less time for discipline.” This conclusion was reported by Molnar et al. (1999) in evaluating the first two years of the five-year Student Achievement Guarantee in Education (SAGE) program in Wisconsin, which was implemented in 1996. This study compared thirty schools that entered the SAGE program to a group of approximately fifteen comparison schools having similar demographics in order to gauge SAGE researchers' claims that reduced class sizes in early grades leads students to higher academic achievement. Targeted toward low-income schools, the SAGE class-size reduction was quite large, ranging from twelve to fifteen students per teacher compared with twenty-one to twenty-five students per teacher in the comparison group. This reduction was larger than in the better-known STAR (Student/Teacher Achievement Ratio) experiment in Tennessee. The gain in test scores was similar to gains attained with STAR, and also consistent with STAR. The greatest gains were posted by African-American students.

Of numerous experiments around the country to reduce class size, the STAR program authorized by the Tennessee legislature in 1985 has received the most attention. Even before the Hanushek, Hedges, and Krueger controversies, it was evident that the statistical evidence relating smaller class size to academic outcomes was uncertain. In turn, legislators in Tennessee launched the STAR project as a random-assignment experiment to more rigorously identify the effects of class size. The program established a class size of approximately fifteen students per teacher. It embraced seventy-nine schools, more than 300 classrooms, and 7,000 students, and followed their progress for four years. STAR compared classes containing thirteen to seventeen students to those containing twenty-two to twenty-six students. Teachers and students were randomly assigned to different-sized classes so that the independent effect of class size could be measured more precisely. The results were clear:

- students in small classes did better in math and reading tests at the end of kindergarten,
- the kindergartner achievement gap between the two class sizes remained the same in first, second, and third grades,
- students from smaller classes behaved better than students from larger classes, and these differences persisted through at least fourth grade,
- the effects were stronger for students of lower, rather than higher, socio-economic status, and
- the effects were stronger for African-American students.

These outcomes have been identified by several researchers (most notably Mosteller 1995 and in a series of papers by Krueger—for example, Krueger 2000 and Krueger and Whitmore 2000). While much of the early work based on STAR data sought to identify short-term effects, many researchers wondered how durable the effects were. Because the STAR experiment began in the 1980s, sufficient time has passed to allow researchers to begin identifying longer-term effects of small classes.

Nye et al. (1999) explored these longer-term effects using data from the Lasting Benefits Study (part of the STAR experiment) to show that the positive effects of small classes are evident in test scores for math, reading, and science at least through eighth grade. Controlling for a variety of confounding factors, such as attrition and variable time in small classes, the authors found that more time spent in small classes is positively related to higher achievement. This work clearly extends the time span for benefits attributed to small class size.

Krueger and Whitmore (2000) also examined STAR's long-term effects. Their main finding was that students who were assigned to small classes were more likely to take the ACT and SAT exams—and that this effect was substantially greater for Blacks than for Whites. Thus while the percentage of students who took the test increased for Whites from forty percent to almost forty-four percent, for Blacks, the increase was from thirty-two percent to more than forty percent. These results withstood a series of increasingly rigorous statistical tests. Moreover, minority students increased their test scores more than White students did, narrowing differences in performance between White and Black students. The time elapse between the STAR experiment and their study was still too short to allow Krueger and Whitmore to link enrollment in STAR's smaller classes to actual enrollment in college (or performance in college once enrolled). However, taking the SAT or ACT exams is the first step toward college, and the higher rate of students who were in small STAR classes taking these tests should ultimately translate into higher enrollment in college.

Conclusion

What is to be concluded from the research presented here?

- School facilities affect learning. Spatial configurations, noise, heat, cold, light, and air quality obviously bear on students' and teachers' ability to perform. Empirical studies will continue, focusing on fine-tuning the acceptable ranges of these variables for optimal academic outcomes. But we already know what is needed: clean air, good light, and a quiet, comfortable, and safe learning environment. This can be and generally has been achieved within the limits of existing knowledge, technology, and materials. It simply requires adequate funding and competent design, construction, and maintenance.
- Building age is an amorphous concept and should not itself be used as an indicator of a facility's impact on student performance. Many schools built as civic monuments in the 1920s and 1930s still provide, with some modernization, excellent learning environments; many newer schools built in the cost-conscious 1960s and 1970s do not.
- There is a definite consensus about the positive effects of small school size, and the effects seem to be the strongest with students from lower socio-economic groups. This is an area, however, where policy makers need the support of studies that better establish the tradeoffs between small schools and other community needs and resources.
- The class size debate is unresolved, although few would argue against smaller classes, where possi-

ble. This is an educational issue that has a serious impact on school planning and design, since smaller classes require more classrooms or more schools, a fact that may seem self-evident but often is lost in the debate.

- There is little standardization of facilities-related definitions. For example, the definition of small schools varies among studies, and overall student-teacher ratios are often (and wrongly) taken as a proxy for class size.
- The quality of facilities-related research ranges widely. Much of it is case-based and verges on the anecdotal, and many literature reviews use simple counts of articles, or they present undocumented summaries of findings. More rigorous approaches to summarizing large bodies of literature, such as metanalytic techniques, are few, and these studies often lead to disagreements over the methods themselves. Better research offering more definitive findings is needed.

Decisions about school facilities, once translated into brick-and-mortar, affect the daily performance of the generations of teachers and students who use them. These decisions are based on tradition, available technology, experience with "what works," and the changing needs of the times. Good facilities research allows us to productively sort through this mix and can help produce long-term, positive effects on academic outcomes.

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For more information, contact the 21st Century School Fund at 202-745-3745, email BEST at info@21csf.org or check the BEST website at http://www.21csf.org/csf-home/BEST/best.htm

Additional Information

See the NCEF resource lists *Impact of Facilities on Learning, Classroom Acoustics, Classroom Color Theory, Daylighting, Healthy School Environments, High Performance School Buildings, Lighting, Indoor Air Quality, Mold in Schools, and School Size* online at http://www.edfacilities.org/rl/

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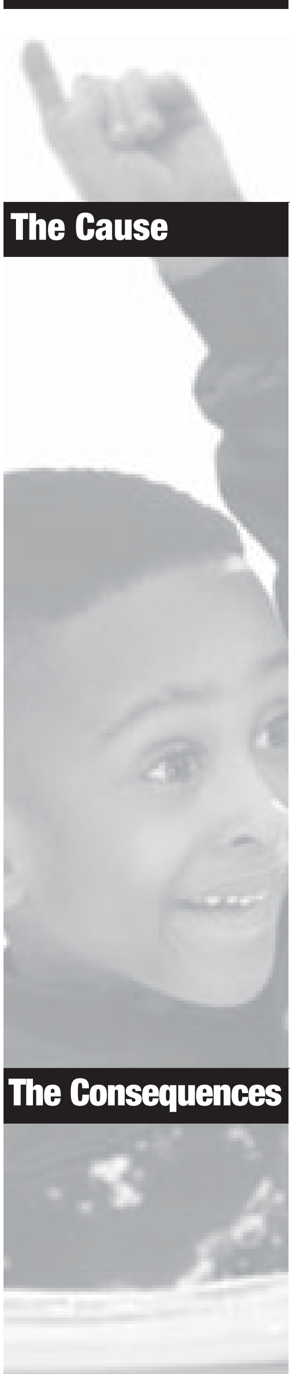


The Problem

How Does Indoor Air Quality Affect a Child's Ability to Learn?

Evidence continues to emerge showing that poor indoor air quality (IAQ) can cause illness requiring absence from school, and can cause acute health symptoms that decrease performance while at school. In addition, recent data suggest that poor IAQ may directly reduce a person's ability to perform specific mental tasks requiring concentration, calculation, or memory.

The Cause

Air in most indoor environments contains a variety of particles and gaseous contaminants. These contaminants are commonly referred to as *indoor pollutants* when they affect human health and performance. Indoor temperature and relative humidity can also affect health and performance directly, and can affect human performance indirectly by influencing the airborne level of molds and bacteria.

Most often, poor indoor air quality results from the failure to follow practices that help create and maintain a healthy indoor environment. Common examples include failure to:

- control pollution sources such as art supplies and laboratory activities
- control temperature and humidity
- control moisture and clean up spills
- ventilate each classroom adequately
- adequately perform housekeeping and maintenance
- use integrated pest management to minimize the use of pesticides

Schools should be designed, built, and maintained in ways to minimize and control sources of pollution, provide adequate exhaust and outdoor air ventilation by natural and mechanical means, maintain proper temperature and humidity conditions, and be responsive to students and staff with particular sensitivities such as allergies or asthma. Failure to deal adequately with any of these issues may go unnoticed, but can and often does take its toll on health, comfort, and performance of teachers and students in school.

The Consequences

Specific Evidence

Illnesses Resulting from Poor Indoor Air Quality Increase School Absences

Evidence from schools that various environmental conditions are closely associated with the incidence of objectively measurable adverse health effects is rapidly emerging. Indoor air quality

[1]Substantial portions of this revised document are based on a literature review funded by the Environmental Protection Agency. The literature review was conducted by Mark Mendell from Lawrence Berkeley National Laboratory, and Garvin Heath from the University of California at Berkeley. Evidence of the association between indoor environmental quality and human performance is taken from school settings wherever possible, but it is supplemented by similar evidence in other environments where information from school environments is lacking.

Recent data suggest that poor IAQ can reduce a person's ability to perform specific mental tasks requiring concentration, calculation or memory.

problems can result in increased absences because of respiratory infections, allergic diseases from biological contaminants, or adverse reactions to chemicals used in schools. Building factors or pollution in buildings most frequently and consistently associated with respiratory health effects are the presence of moisture, water damage, and microbiological pollutants;[1,2] animal and other biological allergens;[3] and combustion products,[4] including nitrogen dioxide.[5,6] Other risk factors for respiratory health effects include: moisture or dirt in HVAC systems;[7,8] low ventilation rates;[9,10] formaldehyde;[6,11-15] chemicals in cleaning products;[16,17] and outdoor pollutants or vehicle exhaust.[18-20]

Children's overall performance decreases due to sickness or absence from school.[21-24] Building-associated health effects can increase student or teacher absences from school and degrade the performance of children or teachers while in school. Respiratory health effects, such as respiratory infections and asthma, are the illnesses most closely associated with increased absenteeism. In fact, asthma-related illness is one of the leading causes of school absenteeism, accounting for over 14 million missed school days per year.[25]

Measured Loss in Performance from Indoor Pollution Sources or Inadequate Ventilation

Recent studies relate direct performance measurements to changes in indoor air quality. For example, a European study of 800 students from 8 schools provides data on indoor air quality, health symptoms, and students' ability to concentrate.[26] In the study, carbon dioxide measurements were taken in the classrooms and students were given a health symptom questionnaire. A computer-based program scored their ability to concentrate. The main source of carbon dioxide in buildings is exhaled breath. Carbon dioxide itself is not a health threat at levels typically found indoors, but when outdoor air ventilation rates are low, carbon dioxide levels and other pollution levels are not diluted as much and therefore also tend to be high. In the study, student scores on the concentration test were lower and their health symptom responses to the questionnaire were inferior when carbon dioxide levels increased. This finding, which was statistically significant, suggests that reduced ventilation rates (and higher indoor pollution) is associated with a decreased ability to concentrate along with increased adverse health symptoms. Another study[27] of students shows similar results when using subjective reports of performance, while laboratory studies of the effects of a mixture of VOC on adults shows that elevated volatile organic compounds (VOCs) can decrease performance of sensitive adults,[28] though not necessarily on those that are not sensitive.[29]

Studies of adults in office settings generally support these associations. In a controlled study of 30 female adults working in an office environment, a 20-year old used carpet, which served as a pollution source, was periodically introduced on racks behind a screen so that subjects had no way of knowing when the carpet was present.[30] The subjects were tested in typing, arithmetic, logical reasoning, memory, and creative thinking during several trials with and without the carpet present. These tasks are similar to the kinds teachers and students perform in school. During the trials without the carpet, the subjects' performance improved in all tasks by 2 – 6 percent. When the carpet was present, the prevalence of headaches during tasks requiring concentration increased, suggesting that at least part of the effect on performance was from pollution-related adverse health effects. In a later study using the same procedure, increasing ventilation rates with the carpet present resulted in statistically significant improvements in performance.[31]

In a similar although more limited study of typing performance and perceptions of air quality, computers were used as the pollution source. Computers can emit a variety of VOCs as internal temperatures of various components rises. In this study, the air was perceived to be fresher and typing performance improved in the absence of the computers.

Evidence is increasing that health, comfort, and performance of adults improve at higher ventilation rates.[32-36] In addition, a recent controlled study in office buildings found that short-

Asthma-related illness is one of the leading causes of school absenteeism, accounting for over 14 million missed school days per year.

term sick leave, often associated with respiratory illness, was significantly associated with low ventilation rates.[10] A subsequent study to test the hypothesis that the sick leave reflected increased respiratory illness failed.[37] The latter study, however, examined a much narrower range of ventilation rates, and related ventilation rates only with sick leave taken during the following week. An alternative explanation supported by sick leave data from this and other studies is that poor indoor air quality increases the probability that individuals will take sick leave even for minor ailments, and delay returning to work during recovery.[38]

Ventilation rates in most schools are below recommended levels, both in the United States and in Europe.[39-44] In fact, in a California study,[39] one third of the schools had ventilation rates that were less than half the recommended levels. Thus, the prevalence of low ventilation rates, combined with the continually growing evidence of the positive impact that outdoor air ventilation has on health and human performance, suggests a clear opportunity for improving IAQ design and management of school facilities. The availability of energy recovery technology in ventilation systems, and the availability of software tools to evaluate the financial implications of this technology,[45] may facilitate acceptance of higher ventilation rates.

Thus, the evidence is increasing in studies of both schools and other settings that indoor pollution or inadequate ventilation can decrease student and teacher performance. These studies reinforce others that relate degradation in indoor air quality with increased frequency of adverse health symptoms or absenteeism. IAQ management in schools, including pollutant source control and provisions for adequate ventilation, appears to provide a healthy indoor environment conducive to improved student and teacher health, higher school attendance, increased school funding, and improved student performance. Furthermore, the pervasive problem of inadequate ventilation in schools provides a significant opportunity to improve school conditions that leads to improved performance of teachers and students.

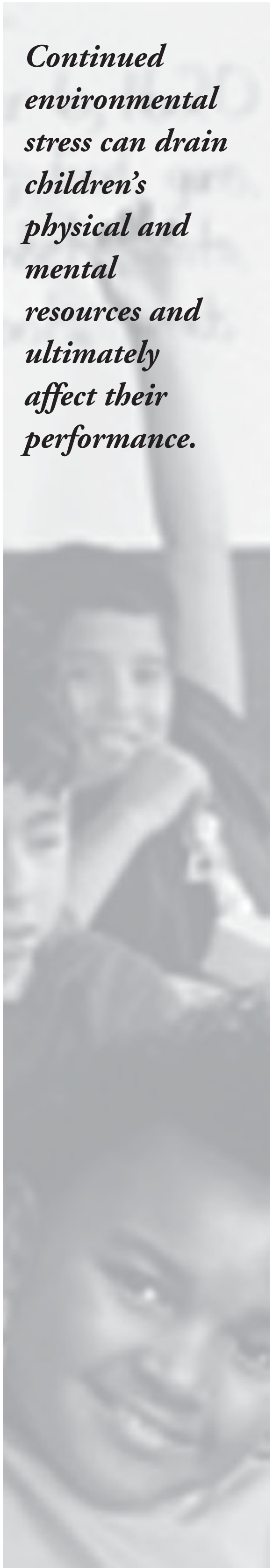
Effects from Mild Symptoms of Distress

What about people who do not have a diagnosable illness, but simply do not feel well? People may report feeling lethargic, having headaches, having a mild sore throat or itchy eyes, or they may have a sense that the air is “stale,” “stuffy,” or “too dry.”

Motivation can often overcome small burdens of environmental stress so that children’s demonstrated performance may not decline. Evidence from adults, however, suggests that continued environmental stress can drain a person’s physical and mental resources and ultimately affect their performance. For example, evidence from office workers suggests that, when individuals experience just two symptoms of discomfort (e.g., dry eyes, itchy or watery eyes, dry throat, lethargy, headache, chest tightness), they begin to perceive a reduction in their own performance. That perception increases as the number of symptoms increases, averaging a 3-percent loss with three symptoms, and an 8-percent loss with five symptoms.[46] This suggests that when large numbers of students and staff experience signs of discomfort related to the air inside their school, teaching and learning performance will degrade over time.

Effects of Temperature and Humidity

In addition to indoor pollution and ventilation, studies suggest that various activities such as typing or driving a vehicle are diminished when people are demonstrably too cold or too hot. Maintaining temperature at the warm end of the comfort zone tends to increase adverse health symptoms, while temperatures at the cool end of the comfort zone tend to reduce symptoms. Similarly, individuals perceive the quality of the indoor air to be better when humidity is at the low end of the comfort zone.[47-49]



Continued environmental stress can drain children's physical and mental resources and ultimately affect their performance.

There is also good evidence that moderate changes in room temperature, even within the comfort zone, affect children's abilities to perform mental tasks requiring concentration, such as addition, multiplication, and sentence comprehension. Overall, warmer temperatures tend to reduce performance, while colder temperatures reduce manual dexterity and speed.[50] In general, the need to avoid extreme conditions and to provide for as much individual temperature control as possible is strongly supported.[51-52]

Will Performance Be Affected Even If No One Is Complaining?

Performance can certainly be expected to suffer if conditions are serious enough for people to complain. The lack of complaints, however, is *not* an indication that performance cannot be improved. For example, in the above studies, symptoms were solicited through questionnaires (as opposed to complaints), and tests were performed on individuals in typical school and office environments. That is, the reductions in performance were recorded under circumstances that easily could have gone unnoticed because of the absence of complaints.

Filtration, Housekeeping, and HVAC Maintenance

One study in schools and several with adult subjects also suggest relationships between health symptoms and airborne or surface-level dust[27,53-55] and between health benefits and good housekeeping protocols that thoroughly remove dust from surfaces.[56,57] Some studies show health and comfort benefits from efforts to reduce airborne particles.[58,59] One such study in an office building showed a statistically significant reduction in mental confusion when 95 percent of airborne particles between 0.3 and 0.5 microns in size were removed by filtration.[60] The study also showed reduced fatigue and improved productivity, although these results were not statistically significant.

Early studies in schools have found that air conditioning is associated with lower absentee rates[61] or improved performance,[62] and that schools with humidification systems are also associated with lower absentee rates. More recent and more rigorous studies in offices, however, show the opposite to be true. This discrepancy may be explained by the fact that, while air conditioning and humidification systems are designed to control temperature and humidity (a positive effect), they may also become contaminated with biological pollutants (a negative effect) if they are not judiciously maintained. A review of building investigation reports also suggests significant benefits to health and performance from good HVAC maintenance.[63] Presumably, these benefits result because properly maintained HVAC systems can provide consistently good thermal and ventilation control while also reducing the risk of biological contamination.

Overall, the evidence suggests that good housekeeping designed to control surface dust plus care and maintenance of the HVAC system, including provisions for good filtration performance, are important aspects of school operating protocols designed to improve student health and performance.

Outdoor Pollution

A major component of an IAQ management plan is the control of pollutants that may enter the school from the outdoors. Studies provide evidence of increased school absenteeism from outdoor pollutants such as carbon monoxide[64] and particles.[64-67] This evidence suggests that particular attention to potential exposures from school bus exhausts and other vehicle exhausts and that improved filtration of particles in locations with high levels of outdoor pollution may be advisable.

The Solution

What You Can Do

Because poor indoor air quality results from failure to follow practices that help create and maintain a healthy indoor environment, being proactive in managing potential IAQ hazards will

assist with maintaining the indoor environment of a school facility. School systems should take advantage of available programs to improve and maintain good indoor environmental quality, and specifically, good indoor air quality in their schools. Programs can be targeted to the maintenance of existing school facilities and to new school construction.

The U.S. Environmental Protection Agency has published voluntary guidance that addresses indoor air quality in schools. By applying no-cost or low-cost approaches outlined in the *IAQ Tools for Schools* (*IAQ TfS*) Action Kit, schools can find cost-effective approaches toward making the school environment more conducive to improved health and performance of teachers and students.

The *IAQ TfS* Kit is free to schools and school districts who make the request on school letterhead. To order the Kit contact the IAQ Information Clearinghouse:

IAQ Info
P.O. Box 37133
Washington, D.C. 20013-7133
Call: 1-800-438-4318, Fax: 703-356-5386, or Email: iaqinfo@aol.com
When requesting the *IAQ TfS* Kit, specify EPA document number 402-K-95-001.

Visit the *IAQ Tools for Schools* Web site and download the Kit, learn about training opportunities, and read about schools around the country that are using the Kit.

www.epa.gov/iaq/schools

Additional Resources
A searchable bibliography of studies dealing with indoor health and productivity (including abstracts of many of the references cited below) is available through the Indoor Health and Productivity (IHP) project. To view, visit http://www.IHPcentral.org

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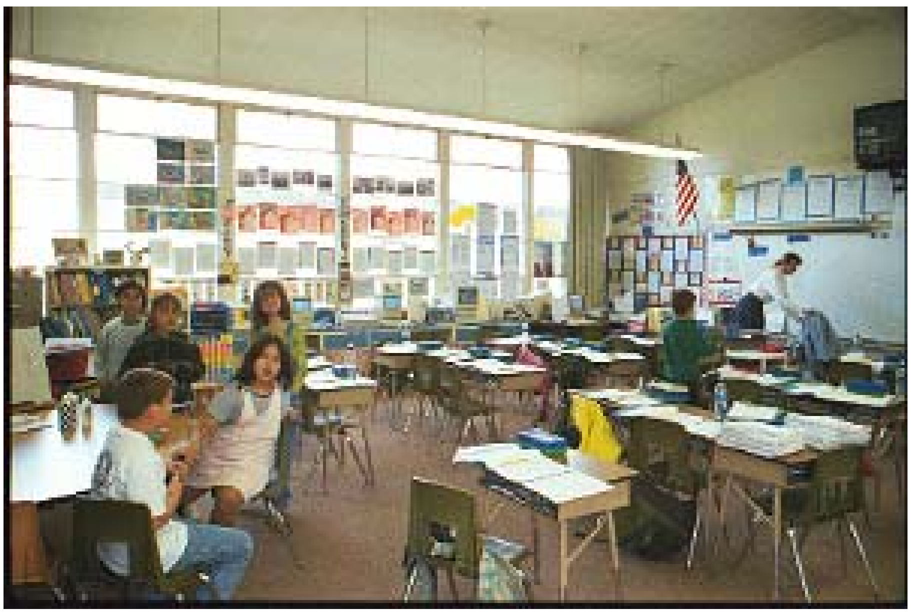
CALIFORNIA ENERGY COMMISSION

Daylighting In Schools: Reanalysis Report



TECHNICAL REPORT

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Gray Davis, *Governor*

CALIFORNIA ENERGY COMMISSION

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PREFACE

The Public Interest Energy Research (PIER) Program supports public interest energy research and development that will help improve the quality of life in California by bringing environmentally safe, affordable, and reliable energy services and products to the marketplace.

This document is one of 33 technical attachments to the final report of a larger research effort called *Integrated Energy Systems: Productivity and Building Science Program* (Program) as part of the PIER Program funded by the California Energy Commission (Commission) and managed by the New Buildings Institute.

As the name suggests, it is not individual building components, equipment, or materials that optimize energy efficiency. Instead, energy efficiency is improved through the integrated design, construction, and operation of building systems. The *Integrated Energy Systems: Productivity and Building Science Program* research addressed six areas:

- Productivity and Interior Environments
- Integrated Design of Large Commercial HVAC Systems
- Integrated Design of Small Commercial HVAC Systems
- Integrated Design of Commercial Building Ceiling Systems
- Integrated Design of Residential Ducting & Air Flow Systems
- Outdoor Lighting Baseline Assessment

The Program's final report (Commission publication # P500-03-082) and its attachments are intended to provide a complete record of the objectives, methods, findings and accomplishments of the *Integrated Energy Systems: Productivity and Building Science Program*. The final report and attachments are highly applicable to architects, designers, contractors, building owners and operators, manufacturers, researchers, and the energy efficiency community.

This attachment (#A-3) provides supplemental information to the program's final report within the **Productivity and Interior Environments** research area. It includes the following report:

- **Daylighting in Schools: Reanalysis Report.** This study expands and validates previous research by Heschong Mahone Group that found a statistical correlation between the amount of daylight in elementary school classrooms and the performance of students on standardized math and reading tests.

The Buildings Program Area within the Public Interest Energy Research (PIER) Program produced these documents as part of a multi-project programmatic contract (#400-99-413). The Buildings Program includes new and existing buildings in both the residential and the non-residential sectors. The program seeks to decrease building energy use through research that will develop or improve energy efficient technologies, strategies, tools, and building performance evaluation methods.

This report is Attachment A-3 (Product 2.2.5) to the Final Report on *Integrated Energy Systems: Productivity and Building Science Program* (Commission Publication #P500-03-082). For other reports produced within this contract or to obtain more information on the PIER Program, please visit www.energy.ca.gov/pier/buildings or contact the Commission's Publications Unit at 916-654-5200. All reports, guidelines and attachments are also publicly available at www.newbuildings.org/pier.

ABSTRACT

The "Daylighting in Schools: Reanalysis Report" is part of the Productivity and Interior Environments research project, one of six research elements within the *Integrated Energy Systems: Productivity and Building Science* Program. The Program was funded by the California Energy Commission's Public Interest Energy Research (PIER) Program.

This study expands and validates previous research by Heschong Mahone Group that found a statistical correlation between the amount of daylight in elementary school classrooms and student performance. The researchers reanalyzed student performance data from two school districts to answer questions raised by the previous study. The reanalysis found that:

- Elementary school students in classrooms with the most daylight showed a 21% improvement in learning rates compared to students in classrooms with the least daylight.
- There was no teacher assignment bias that might have skewed the original results; more experienced or more educated teachers were not significantly more likely to be assigned to classrooms with more daylighting.
- The daylighting effect does not vary by grade.
- Physical classroom characteristics (daylighting, operable windows, air conditioning, portable classrooms) do not have an effect on student absenteeism. This seems to contradict claims that have been made about the health effects of daylight or other environmental conditions, as reflected in absenteeism rates of building occupants.

These results, which are consistent with the original findings, affirm that daylight has a positive and highly significant association with improved student performance. These findings may have important implications for the design of schools and other buildings.

Author: Lisa Heschong, Heschong Mahone Group

Keywords: Daylight, Productivity, Student Performance, Window, Skylight, Absenteeism, Attendance, Health, Classroom Condition, School Design

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EXECUTIVE SUMMARY

This report is a follow-on study to the Daylighting in Schools study[1] that was completed in 1999, which found a compelling statistical correlation between the amount of daylighting in elementary school classrooms and the performance of students on standardized math and reading tests. This re-analysis of the original study data was intended to answer key questions raised by the peer review of the earlier study, and expand our understanding of methodological choices for further work.

The original findings potentially have very important implications for the design of schools and other buildings where people live, work and play. Daylight used to be common and even required in schools, homes and offices, but fully daylit buildings became increasingly rare as electric lighting became more the norm. This re-analysis study helps to provide greater certainty for the original findings.

For this re-analysis study HMG conducted four tasks:

The **Teacher Survey** collected information from a sample of teachers in the Capistrano school district about their education and experience levels, preferences for classroom features and operation of those features. The primary purpose of the survey was to provide input to a subsequent "assignment bias" analysis. In addition, we learned some useful information about teacher preferences, attitudes and behaviors in response to classrooms conditions.

While the teachers we surveyed generally had a preference for windows, daylight and views in their classrooms, these preferences were not found to be driving classroom preferences. Far more important was an almost universal desire for more space, a good location, quiet, lots of storage and water in the classroom.

Environmental control was also found to be an important issue for teachers, especially for those who did not have full control. Teachers seemed to hold a basic expectation that they would be able to control light levels, sun penetration, acoustic conditions, temperature and ventilation in their classrooms. They made passionate comments about the need for improvement if one or more of these environmental conditions could not be controlled in their classroom.

The Teacher **Bias Analysis** further examined information from the Teacher Survey. The survey data was coded into variables and statistically analyzed in relation to both assignment to daylit classrooms and the student performance models. The goal of the Bias Analysis was to discover if the original study had over-inflated the effect of daylight on student learning by not accounting for a potential "assignment bias" of better teachers to more daylit classrooms.

We conclusively found that there was not an “assignment bias” influencing our results. None of the individual teacher characteristics we identified were significant in explaining assignment to a daylit classroom in the Capistrano District. Considering all teacher characteristics together only explained 1% of the variation in assignment to daylit classrooms. We did find that a few types of teachers, those with more experience or

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[1] Heschong Mahone Group (1999). Daylighting in Schools. An investigation into the relationship between daylight and human performance. Detailed Report. Fair Oaks, CA. (http://www.h-m-g.com/Daylighting/daylighting_and_productivity.htm)

honors, were slightly more likely (1%-5%) to be assigned to classrooms with more windows or some types of skylights.

When we added the teacher characteristics to the original student performance models, the daylight variables were not reduced in significance. Further analysis of other sub-populations repeated these findings. Among twelve models considered, we identified a central tendency of a 21% improvement in student learning rates from those in classrooms with the least amount of daylight compared to those with the most.

In the **Grade Level Analysis**, we re-analyzed the original student test score data for both Capistrano and Seattle by separate grade level, instead of aggregating the data across the four grade levels (2-5). Our goal was to determine if this method would more accurately explain the relationship of student performance to daylighting. We tested for statistical significance and correlation, and we looked at any patterns discovered in the analysis.

The data did not show any significant patterns between a daylight effect and the separate grade levels, neither an increase or decrease in daylight effects by grade level. Thus, we conclude that there do not seem to be progressive effects as children get older, nor do younger children seem to be more sensitive to daylight than older children. Allowing the results to vary by grade did not noticeably improve the accuracy of the models. Therefore, we conclude that looking at data across grade levels is a sufficiently accurate methodology.

In the **Absenteeism Analysis**, we used absenteeism and tardiness data in the original Capistrano data set as dependent variables and evaluated them against the full set of explanatory variables from the original study, plus the new information on teacher characteristics. These models would allow us to assess whether daylighting or other classroom physical attributes potentially impacted student health, as measured by changes in student attendance.

Student attendance data is certainly not the best indicator of student health. Yet to the extent that attendance data does reflect student health, our findings do not suggest an obvious connection between physical classroom characteristics and student health. Notably, daylighting conditions, operable windows, air conditioning and portable classrooms were not found to be significant in predicting student absences.

Overall, the strength of the daylight variable in predicting student performance stands out sharply across all of these re-analysis efforts.

This analysis also demonstrated that the findings of these models are more strongly dependent upon the sample population then the subtleties of the explanatory variables. Thus, we believe that it will be more informative to replicate this study with a different population, to continue to try to refine the models with further detail in the explanatory variables.

1. INTRODUCTION

The Daylighting in Schools study[1] completed in 1999 by the Heschong Mahone Group on behalf of the California Board for Energy Efficiency found some a compelling statistical correlation between the amount of daylighting in elementary school classrooms and the performance of students on standardized math and reading tests.

The study was reviewed by a panel of experts, recruited by Lawrence Berkeley National Laboratory and involved a wide range of disciplines related to the study. In general the review panel was satisfied with the soundness of the basic methodology and the rigor of the statistical analysis. An additional “classroom level analysis” (included in the Appendix of the detailed version) verified the robustness of the initial results. The peer reviewers, however, expressed two primary concerns[2] that could only be addressed in follow-up studies. These are:

1. The results might be confounded by a potential bias whereby "better" teachers might be more likely to be assigned to more daylit classrooms

2. The analysis might be more accurate if performed by grade level, rather than aggregating data from four grade levels together

The study described in this report, supported through the California Energy Commission's Public Interest Energy Research (PIER) program, was designed to address these two concerns, while also expanding other areas of our knowledge about the interaction of students, teachers and daylighting. The series of four tasks described in this report were the necessary first steps in resolving remaining questions about the Daylighting and Schools study. The results of these initial re-analysis studies will also be used to inform the methodology and data collection for the forthcoming PIER productivity studies in schools, retail, manufacturing, and offices.

This report discusses the re-analysis of the 97-98 school year student performance data on standardized math and reading tests from the Capistrano Unified School District in Southern California and the Seattle Public School District in Seattle Washington. The re-analysis of the original study data was intended to answer key questions raised by the peer review of the earlier study, and expand our understanding of methodological choices for further work.

[1] Heschong Mahone Group (1999). Daylighting in Schools. An investigation into the relationship between daylight and human performance. Detailed Report. Fair Oaks, CA.

[2] Heschong Mahone Group (1999). Daylighting and Productivity. An investigation into the relationship between daylight and human performance. Review Report. Fair Oaks, CA.

1.1 Study Tasks

Four study tasks were defined, which are briefly summarized here, and described fully later:

- Teacher Survey
- Teacher Bias Analysis
- Grade Level Analysis
- Absenteeism Analysis

The **Teacher Survey** surveyed a sample of teachers in the Capistrano school district to determine their years of teaching experience, education level, and other characteristics that might be associated with being a "better" teacher. While we were conducting a survey, we decided to include a few additional questions to learn more about the teacher's perspective on classroom assignments, their preferences for the physical qualities of classrooms, and how they operated their classrooms.

The survey fed into the second task **Teacher Bias Analysis**. The teacher information from the survey was coded into variables that could be analyzed statistically. First we looked at the assignment bias, to see if some types of teachers were more likely to be assigned to more daylit classrooms in the Capistrano District. Next, we added the information about the teachers to the original Capistrano student test score models to see if accounting for teacher characteristics would impact the significance or magnitude of the daylight variables.

In addition to the tasks described above, we also re-analyzed the original data in two other ways. The **Grade Level Analysis** looked at the original student test score data for both Capistrano and Seattle by grade level to see if this was a more accurate way to study the relationship of student performance to daylighting.

The original Capistrano data set also included information on student attendance--both absences and tardiness. This gave us the opportunity to see if daylighting, or other physical characteristics of the classrooms in Capistrano, were associated with changes in attendance. For the **Absenteeism Analysis** task, we set student absenteeism and tardiness as dependent variables, and used the full set of explanatory variables used in the original study, plus the new information on teacher characteristics, to see if daylighting or other classroom attributes were associated with student attendance.

1.2 Literature Review of Research on Teachers' Influence

We looked to research by educational researchers in our effort to understand how teacher characteristics might be described and included in our models. Various educational researchers have analyzed the relationship between teacher performance and student achievement, and have identified a number of teacher characteristics that seem to fairly reliably predict student learning in the classroom. Factors that have been found to be significant in previous studies include a teacher's general intelligence, teaching experience, certain personality traits, knowledge of the subject matter, knowledge of teaching strategies, continuing education, and certification[1]. The following summary is based on an extensive literature review by Prof. Linda Darling-Hammond of the Stanford University School of Education (Darling-Hammond 2000) of the recent research on the relationship between teacher performance and student achievement. The reader is referred to her report for specific citations or further detail on studies.

This literature review helped inform the classification of teacher characteristic variables for in this study. The discussion below includes both the approach of other researchers to define variables of interest and a brief summary of some of their findings.

General intelligence: General intelligence as measured by IQ test or college grade point average shows the weakest performance as a predictor of subsequent student performance. While early studies in the 40's positively correlated teachers' intelligence and student achievement, these correlations are generally statistically insignificant and have not held up over time. Two meta-reviews of these studies performed in the 80's found little or no correlation.

Teaching experience: Researchers have usually measured teaching experience by the number of years a teacher has spent in the profession. While various studies have found a positive relationship between teachers' experience and student learning, this relationship is not always significant or linear. Although many studies conclude that inexperienced teachers generally perform less well than those with more experience, the benefits of experience tend to level off after approximately five years. This seems, however, to be dependent on the organizational structure of the school district: in districts that emphasize the importance of continuing education, long time teachers are more likely to improve throughout their career.

Teacher personality traits: Studies have found scant correlation between student learning and various teacher personality traits. One exception is a set of personality traits variously defined as "flexibility," "creativity," or "adaptability." This would seem to be consistent with a theory that a teacher's ability to creatively adjust their teaching methods to fit the needs of the students and the instructional goals would correlate positively with student learning. Some researchers have found that "flexibility" is also closely correlated to variables measuring a teacher's professional education, implying that teachers who have studied formally are more likely to be able to adjust teaching strategies for students' different learning styles.

Knowledge of subject matter: Knowledge of the subject matter to be taught, as measured by number of college classes taken or by scores on a subject matter

[1] Darling Hammond, L. (2000). Teacher Quality and Student Achievement: A review of state policy evidence. Education Policy Analysis Archives, Vol. 8, number 1, available on-line, http://epaa.asu.edu/epaa/v8n1/

test, has been found to be less important than might be expected. A variety of studies have shown small, statistically insignificant relationships, both positive and negative. One recent study found that teachers' coursework in the subject field relates positively to student achievement in mathematics and science, but that the number of courses show diminishing returns above a certain threshold level (Monk, 1994). A teacher's knowledge of the subject was found to be more important for higher-level classes and higher-achieving students (Hawk, Coble, & Swanson, 1985). Thus, a certain level of subject matter knowledge appears important, but above that point, other factors, such as the ability to effectively convey this knowledge, become more important to student achievement.

Teaching strategies: Knowledge of teaching strategies has been measured by number of education classes taken in teaching methods and level of college degree (BA or MA). These variables generally capture variance in teacher performance more effectively than the variables discussed above. Ferguson and Womack (1993) studied 200 graduates of one teacher education program. They concluded that the amount of education coursework was responsible for more than four times the variance (16.5 %) in teacher performance than measures of content knowledge, as determined by National Teacher Examination subject matter test scores and GPA in the major (4.5 %).

Continuing education: It is also seems to be important that teachers continue to refresh and update their knowledge through continuing education. Greater student achievement has been linked to mathematics teachers' opportunities to participate in sustained professional development courses. Similar results have been suggested for literature-based instruction. Not only is the amount of ongoing education important, but also how recent it is.

Certification: Standard certification usually requires a teacher to graduate from an accredited teacher training program, have a major or minor in the field to be taught, and pass a test on basic skills and teaching strategies. Therefore, certification status (standard certification vs. emergency, temporary or provisional certification issued to those lacking the above credentials) is a measure of both knowledge of the subject and of teaching skills. Linda Darling-Hammond compiled data from all 50 states using the 1993-94 Schools and Staffing Surveys (SASS) and the National Assessment of Educational Progress (NAEP). She found that at the state level, the percentage of well-qualified teachers (with full certification and a major in their field) was the strongest, consistently positive predictor of student achievement ($.61 < r < .80$, $p<.001$) while the percentage of newly hired, uncertified teachers was the strongest, most consistently negative predictor of student achievement ($-.63 < r < -.40$, $p<.05$).

Scores on state licensing examinations: Another variable that combines several important factors are scores on state licensing examinations, which test both basic skills and teaching knowledge. Ronald Ferguson (1991) examined 900 Texas school districts, controlling for student background and district differences, and found that a combination of teacher qualification variables – scores on a licensing examination, education level, and years of experience -- explained more of the inter-district variation in students' reading and mathematics achievement gains than student socioeconomic status. The strongest of these variables were the scores on the state licensing exam.

1.2.1 Differences with Our Study

These studies formed a context of our work. However, the goal of our study was not to determine the effect of teachers' credentials, qualifications, and experience on student performance. Our goal, rather, was to discover whether daylighting in classrooms remained a significant indicator of student performance even when teacher characteristic variables were included in a statistical regression model. Thus, our study differed from those discussed above in several important ways.

First of all, our data collection procedure of teacher variables was limited, due to privacy concerns, to the variables we could reliably measure through self-reporting. We had to exclude original sources such as transcripts, college or licensing board test scores, or classroom observations.

Second, the data in other studies was often aggregated to the district or state level. We, on the other hand, analyzed the data at the student and classroom level, which may yield different results or emphasize different factors.

1.3 Summary of Previous Study

For the original schools study we identified three study sites of large school districts that had a range of daylighting conditions in their classrooms. We collected test scores and demographic information for all second through fifth graders in the district, and classified their classrooms for the amount and quality of daylight available. We choose to work with data on elementary school children since they typically spend all year in one classroom. Thus, we could directly isolate the effects of that one classroom. We also specifically selected districts that had a number of classrooms lit from above with skylights or roof monitors ("toplighting"). We reasoned that daylight provided through windows might have a number of complicating factors, such as the quality of view, whereas daylight provided from above typically had fewer other qualities that might influence results, thus we would be more likely to be looking a pure "daylighting" effect.

The three districts were located in San Juan Capistrano, (Southern) California; Seattle, Washington; and Fort Collins, Colorado. These three districts have very different climates, different school building types, different curriculums and different testing protocols. The districts also provided us with information about student demographic characteristics, special school programs, size of schools, etc.

We added information to these data sets about the physical conditions of the classrooms to which these children were assigned. We reviewed architectural plans, aerial photographs and maintenance records and visited a sample of the schools in each district to classify the daylighting conditions in over 2000 classrooms. Each classroom was assigned a series of codes on a 0-5 scale (see Figure 1) indicating the size and tint of its windows, the presence and type of any skylighting, and a holistic daylighting code indicating the overall quality and quantity of daylight expected from both windows and toplighting combined. In Capistrano, the skylights were given a variable type (A, AA, B, C, D) rather than a scalar. The configuration of these skylight types is described in the original report. The *Daylight Code*, which is used predominately for reporting findings in this report, was based on the following qualitative criteria, with foot candle levels at midday conditions are provided as an illustration rather than a criteria.

Daylight Code 5	Classroom is adequately and uniformly lit with daylight, such that teacher could successfully instruct with electric lights off, for most of the school year. 50± footcandles on most desks.
Daylight Code 4	Classroom has major daylight component, and could occasionally be operated without any electric lights. Daylight may have strong gradient. 30± footcandles on many desks.
Daylight Code 3	Classroom has adequate levels in limited areas, such as near windows. Some, but not all, electric lights could occasionally be turned off. 15± footcandles at some desks.
Daylight Code 2	Classroom has poor and/or very uneven daylight. Not likely to ever operate without electric lights fully on. 10± footcandles in limited areas.
Daylight Code 1	Classroom has minimal daylight. Very small and/or darkly tinted windows or inadequate toplighting. Not possible to operate without electric lights. 5± footcandles in limited areas.
Daylight Code 0	Classroom has no daylight.

Figure 1: Daylight Code Definitions

Ultimately the study analyzed test scores performance for 8000 to 9000 students per district. We looked at both math and reading scores in all three districts, and analyzed each separately, alternately using the holistic daylight code and the separate window and skylight codes, for a total of twelve statistical models.

The Capistrano Unified School District proved to be our most interesting study site for a number of reasons. The District administers standardized tests both in the fall and spring, allowing us to compare the change in students' math and reading test scores while they spent the year in one classroom environment. Because the District, like most in California, has a number of standardized portable classrooms at every elementary site, we were able to use these portables as a standardized condition controlling for the influence of individual school sites or neighborhoods. We also collected additional information at this district about the HVAC and ventilation conditions of the classrooms, which was also included in the analysis.

In Capistrano, using a regression equation that controlled for 50 other variables, we found that students with the most daylighting in their classrooms progressed 20% faster on math tests and 26% on reading tests in one year than those with the least. Similarly, students in classrooms with the largest window areas were found to progress 15% faster in math and 23% faster in reading than those with the least. Students that had a well-designed skylight in their room, one that diffused the daylight throughout the room and which allowed teachers to control the amount of daylight entering the room, also improved 19-20% faster than those students without a skylight. Classrooms with a skylight that allowed direct beam sunlight into the classroom and did not provide the teacher with a way to control the amount of daylight were actually seen to have a negative association with student performance. In addition, in three of the four Capistrano models, the presence of an operable window in the classroom was also seen to have a positive effect on student progress, associated with 7-8% faster learning. These effects were all observed with 99% statistical certainty.

The Seattle and Fort Collins school districts administer only one standardized test at the end of the school year. In these districts, the study used the final scores on math and reading tests at the end of the school year and compared the results to the district-wide average test score. In both of these districts we also found positive and highly significant (99%) effects for daylighting. Students in classrooms with the most daylighting were found to have 7% to 18% higher scores than those with the least.

The three districts have different curricula and teaching styles, different school building designs, and very different climates. And yet, the results of the studies show consistently positive and highly significant effects. This consistency across such diverse school environments persuasively argues that there is a valid and predictable effect of daylighting on student performance.

These models explained from 25% to 44% of the variation in student scores (R^2= .25 to .44). Thus another 56% to 75% of the variation might be explained by other factors not included in our equation such as teacher quality, home life, health, nutrition, individual talents and motivation, etc. There always remains the possibility that some other variable left out of the equation is influencing results on the variable of interest.

Reviewers of the original school study specifically asked if “better” teachers were more likely to be assigned to the more daylight classrooms, thus influencing the results. Additionally, they asked if the analysis might be more accurate if performed by grade level rather than aggregating data from four grade levels together. This follow-on study addresses those concerns by re-examining our most detailed models for the Capistrano district.

2. TEACHER SURVEY

The first task for the follow-up study was to collect additional information about the teachers that could be added to the original models. We choose to work with the Capistrano Unified School District for three reasons: they had provided us with the most detail in the original study, they were willing to cooperate with us on further studies, and they were physically the closest district to us.

2.1 Methodology

We asked the District the best way to compile additional information about the specific teachers in the study that would be useful in our re-analysis. The District was unable to provide us with information about their teachers directly due to confidentiality restrictions. However, they agreed that we could solicit such information from the teachers, in a survey. A survey gave the teachers an opportunity to decline to participate, and allowed us to collect additional information that could be kept confidential from the District.

We agreed that the District would review and approve the instrument, and also help us to locate the teachers in our sample for distribution of the survey. A two-page survey was developed and reviewed by the District and members of our Technical Advisory Committee. A draft version was tested on a number of local elementary teachers for ease of use and clarity.

The final survey, with a explanatory cover letter from the District office, was distributed to a stratified sub-sample of teachers from our original data set. We identified 14 schools with a balanced sample of all window and skylight conditions found in the original 27 elementary schools included in the 97-98 database. Our goal was to achieve a sufficient population of teachers in each daylighting condition, in order to have the best chance to achieve statistical certainty in our new analysis. We provided the District a list of all teacher names used in mapping the data for those 14 schools. The District then located these teachers for us. Over the two year period, between the survey and the original data mapping, about 17% of the teachers had left the district or moved to non-teaching jobs and about 6% had re-located to a different school in the district. As a result, our sub-sample of teachers now resided at every elementary school in the district.

Surveys were mailed to each school office, with a list of teachers to whom they were to be distributed. After two days, the responses were collected in a confidential master envelope and returned to us for analysis. Ultimately, we received completed surveys from 68% of the teachers on our distribution list, or 206 teachers, representing 3900 students in our data set. Some school offices disregarded our list and distributed the survey to all of their teachers, so we received responses from an additional 44 teachers who were not in our original study, for a total of 250 responses.

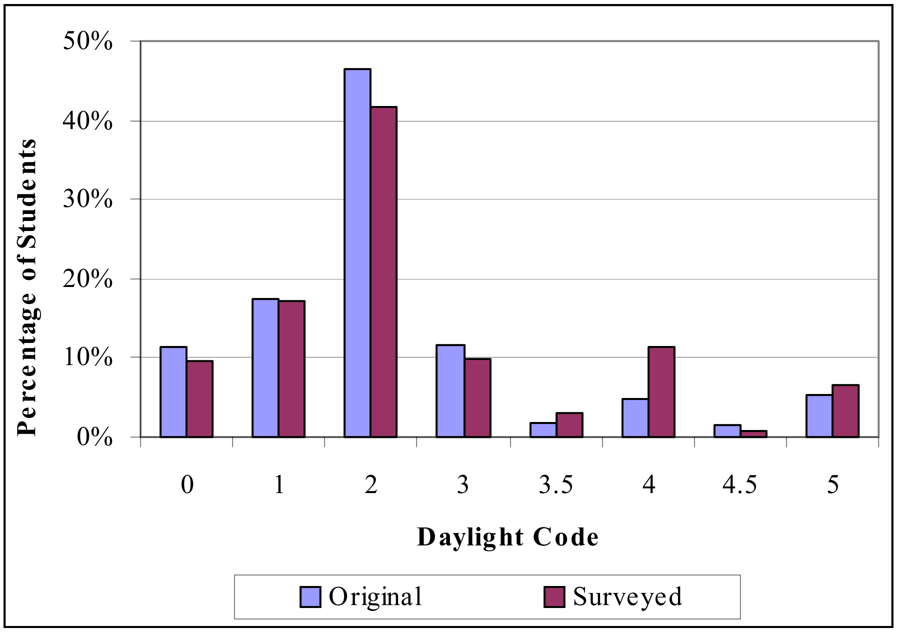


Figure 2: Surveyed vs. Original Population Distribution by Daylight Code

Figure 2 shows the resulting distribution of students by *Daylight Code* for the surveyed population compared to the original population of the study. The two populations are reasonably similar. There is a slight increase in the proportion of teachers in the higher daylight codes (3.5+) due to our concern that our sample include enough teachers to support statistically significant analysis. The reduction in *Daylight Code* 2 reflects a lower sampling of teachers in portable classrooms.

2.1.1 Survey Structure

The two-page survey instrument, provided in Appendix 7.1, contains both structured and open-ended questions. The primary purpose of the survey was to collect information about teacher characteristics that could be included in our models of student performance in daylit classrooms. Thus, the survey first asked for the classroom and grade assignment for both the current year and the 97/98 school year so that we could verify our data mapping. It then asked for the teacher's education level, certificates, additional coursework, special honors, and years of teaching experience—in the current school, district and total.

In addition, we collected information about the teachers' perception of any "assignment bias," their preferences for classroom selection, and additional information about how they operated their classrooms. While this information was not part of the primary intent of the survey, it was hoped that such information might provide valuable insight in future analysis.

Thus, the survey was designed to answer the following questions:

1. What are the educational qualifications and experience of the teachers who taught in classrooms included in the 97-98 data set?
2. Did they believe that they have been allowed to choose their own classroom or have any influence on where they are assigned?
3. If they could choose a classroom, what attributes of a classroom would they give top priority in their selection?
4. How do these teachers operate the energy-using features of their classrooms? For example, if they have operable windows, how often do they open them?

2.2 Teacher Characteristics

The survey responses were categorized, cleaned and entered into a database. Information from open-ended questions was coded for analysis. The teacher characteristic information was eventually transformed into variables for inclusion in the statistical models of later tasks in this study.

The Capistrano Unified School District tries to maintain uniformly high education and training standards among its teachers, which tends to reduce the variation in teacher quality across classrooms. In discussions with Capistrano administrators prior to the survey, we were told that the District was not hiring teachers with provisional or emergency credentials. Beyond requiring all of their teachers to be certified, the district highly values continuing education for all teachers. A sliding salary scale rewards additional college education, in addition to years of experience. The District also provides opportunities for on-site training classes that are specifically tailored to the curriculum needs of the district.

2.2.1 Years of Experience

The 250 teachers who responded to the survey varied in their teaching experience from one or two years to more than 40 years. They averaged 11 years of teaching in the CSUD district and 13.5 years of teaching in total (see Figure 3).

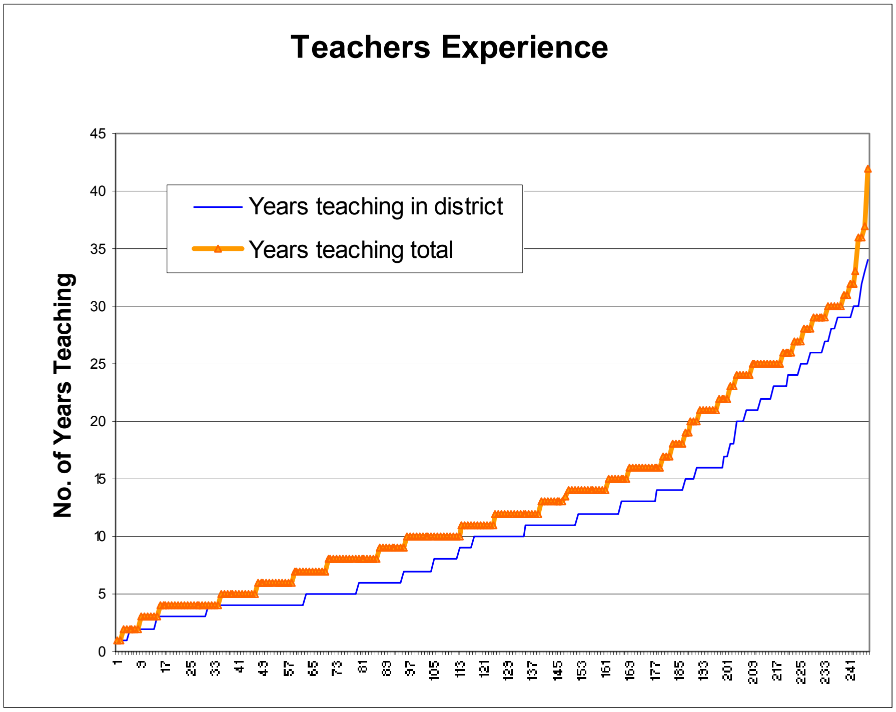


Figure 3: Number of Years Teaching for Survey Respondents

2.2.2 Education Level, Certificates and Honors

Teachers were asked to report their highest educational degree, plus additional college course work, training programs, and special certificates and honors. This information was described qualitatively by the teacher respondents, thus we needed to classify the responses into meaningful categories that could be used to analyze the data. The first step was to understand the educational requirements for elementary school certification in California, and similarly the District's standards for hiring and promotion.

There are two levels of accreditation in California elementary schools. A Preliminary Credential is good for the first five years of teaching. It requires as a minimum completion of a bachelor's degree and a teacher preparation program, knowledge of the US Constitution, plus additional certification in teaching reading, passing a standardized test of knowledge (CBEST) and the multiple subject assessment for teachers (MSAT). The second level of accreditation is called the Professional Clear. It requires an additional fifth year of study beyond the bachelor's including course work in computer, health and special education.

Based on interviews with the District personnel officers and review with our Technical Advisory Group, we decided to group the teachers' education levels for analysis into two simple categories, BA and MA, with three sub-categories, as follows:

- **"BA"** indicated any teacher with a bachelors degree
  - **"Clear only"** indicated teachers who had been teaching for 7 years or more, but had not pursued any continuing education beyond that necessary for their professional clear credential.
  - **"BA Plus"** indicated teachers who listed college credits beyond the minimum required for certification
- **"MA"** indicated those with a masters, or doctorate (one case)
  - **"MA Plus"** identified teachers with college credits beyond a master's degree.

In our sample of surveyed teachers (Figure 4), 58% had Bachelor degree, of which 12% had only a BA and had taught for 6 years or less, 12% were grouped in the Clear Only category, 34% were grouped in the Bachelor Plus category; 42% of the teachers reported having a Masters degree, of which 29% had just an MA, and 13% were grouped in the Masters Plus category,

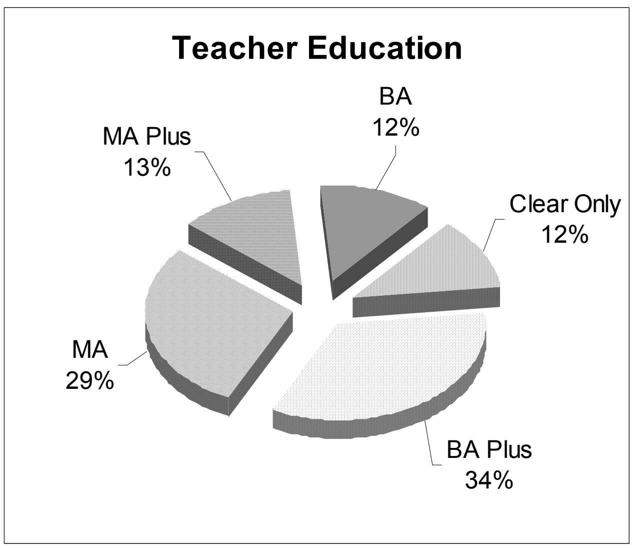
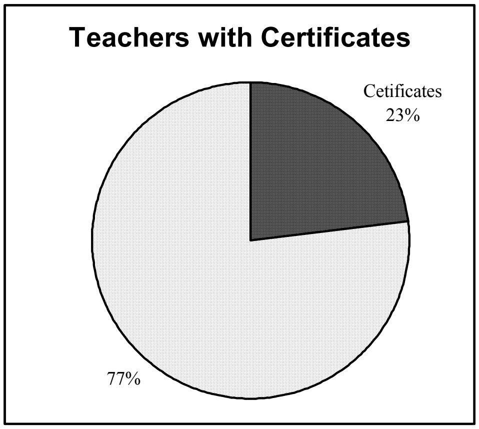


Figure 4: Teacher Education Level

In addition to their qualifications, teachers also reported other credentials that identified if they have received any special certificates or honors. From this information we defined two other analysis categories:

- The ***Certificates*** category included teachers, who reported special certificates beyond those required for the CLEAR credential, such as a certificate in bilingual or gifted and talented education.
- The ***Honors*** category grouped together all teachers who reported special awards or honors, such as being named a mentor teacher or Teacher of the Year.

Figure 5 shows the proportion of surveyed teachers who were classified into these two categories.



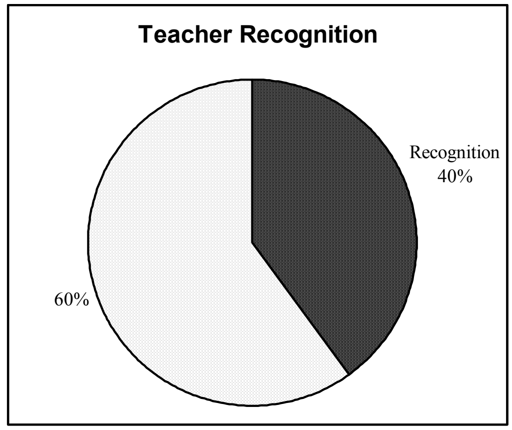


Figure 5: Teacher Certificates and Honors (Recognition)

2.2.3 Classroom Preferences

We pursued a number of different methodologies to understand if there was an intentional or unintentional bias in assigning some teachers to more daylit classrooms. In our original study we had interviewed administrators and principals in the district, who assured us that there was no obvious mechanism or practice of assigning "better" teachers to more daylit classrooms. Given the rapid growth of the district, frequent reassignment of classrooms to accommodate new school openings and added portable classrooms tended to randomize teacher classroom assignments on a fairly regular basis. In addition, it was reported that each school site follows its own administrative criteria in assigning teachers to classrooms, using criteria such as clustering of grade levels or special interest teaching teams.

From the Teacher Survey we found a slightly different story. Of the teachers surveyed, 32% felt that they may have had *some* influence on the selection of their classrooms within the past year (a yes answer to Question 14) and 41% answered yes or maybe. Similar percentages reported that they may have had past influence. Thus, the teachers seemed to feel that they could influence classroom selection.

When asked to indicate their top criteria for selection of a classroom, if they were to have a choice (Question 15), 8% of the sample ranked windows or natural light as their top criteria, and 27% mentioned windows, natural light or view within their top three choices. Lumped together, these three criteria would have placed fourth in importance as a classroom selection criteria, after classroom size (53%), convenient location (36%), and storage capacity (30%). (See Figure 6 and discussion in Section 2.2.4 below.) Thus, while windows and associated qualities light natural light and view are important to teachers, they are not the most important criteria that teachers claim drive their choices.

In addition to the structured questions, teachers were given the opportunity to write any comments they wished. Over two hundred, or 80%, took the opportunity to write informative comments, while three complained about not enough time to respond. (See Appendix 7.1.3 to read the un-edited comments) Their comments read as a loud plea for better physical conditions in the classroom. The reader should realize that many of the comments are referring to class-size reduction measures that were instituted in the District to increase the number of teaching spaces, but unfortunately have compromised physical comfort and control. The passion for control of physical conditions--lighting, acoustics, ventilation and thermal comfort--is also very evident in these comments. The list of comments should make compelling reading for anyone managing or designing school facilities.

2.2.4 Criteria for Classroom Selection

The survey, in an open-ended question, asked what were the three most important criteria that the teacher would use to select a classroom, if they were given the choice. We grouped the qualitative responses into the following categories, reported in the order of their frequency of mention within the top three criteria:

- *Size* indicated teachers' preference for larger classrooms and was most frequently listed in the top three criteria, mentioned by 53% by respondents. It was also the most frequently listed as the top preference.
- *Location* of the classroom within the school layout was the second most common criteria in determining their classroom choice (36%), and was also second as the top criteria. The location preferences included close proximity to the school entrance, administrative offices, playground, library, or other elements of the school plan.
- *Storage* space inside the classroom in the form of closets or cupboards was the third most mentioned criteria.
- *Water* or the availability of a sink in the room was among the top four most mentioned criteria. Comments typically emphasized the primary importance of water in the classroom for student hygiene, and secondarily for class projects.
- *Quiet* captured criteria such as "lack of noise" and "being in a quiet zone." It was the fifth most common criteria (23%) mentioned in any of the top three preferred classroom attributes by teachers, and third criteria in terms of teachers' top preference (after classroom size and location).
- *Windows* were mentioned by 20% of the respondents.
- *HVAC* indicated a preference for air conditioning in the classroom, or control of temperature, or acceptable thermal comfort conditions.

- *Door* indicated a preference for full enclosure or the availability of a door to close off the classroom from other activity areas.
- *Proximity* indicated a preference for a classroom close to particular colleagues, either by grade level or shared teaching responsibilities.
- *Condition* indicated a preference for better physical conditions, such as new paint, furniture or carpet, or good maintenance.
- *Ventilation* indicated a preference for fresh air or good air circulation.
- *Lighting* indicated preference for a good lighting quality in the classroom or control of the lighting levels.
- *Natural light* indicated a preference for natural light from windows or skylights.
- *Walls* indicated a preference for lots of wall surfaces for display.
- *Bathroom* indicated a preference for a bathroom close by.
- *Views* indicated a preference of a good view from the classroom.
- *Whiteboards* indicated a preference for lot of whiteboard surfaces.
- *Phone* indicated a preference for a telephone available in the classroom.
- *Workroom* indicated a preference for being adjacent to a teacher workroom.

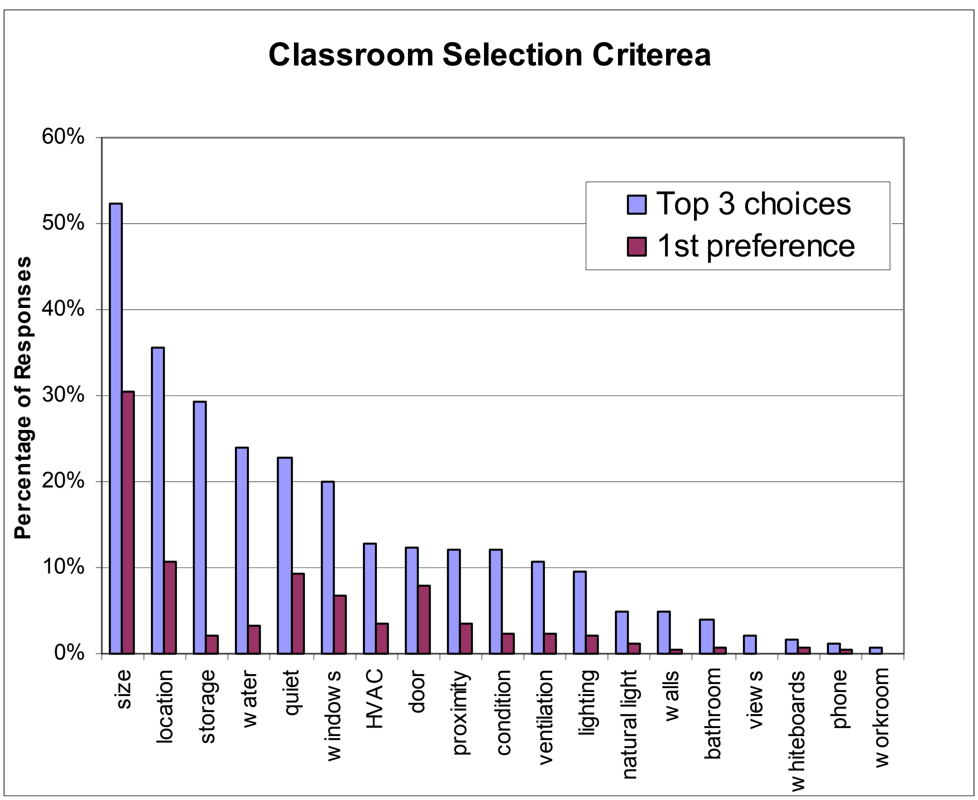


Figure 6: Most Preferred Attributes of Classrooms

It should be noted that the teachers' preferences for classroom features is largely a function of what options are, or are not, currently available to them. For example, a teacher in a school without windows but the option of moving to a portable with a window may rank windows very high, while a teacher in a classroom with large windows but no sink, may rank access to water highest. Thus, we interpret these results to be particular to the context of the Capistrano Unified School District and the status of current facilities.

2.2.5 Permanent vs. Portable Classroom Preference

The use of portable classrooms in California was mandated by the state for a number of years as a strategy to accommodate rapidly shifting population growth. As a consequence, every school site in our Capistrano study had a substantial number of portables. Portable classrooms have also come under recent scrutiny for possible poor indoor air quality or other health concerns such as mold growth. A number of state and national studies are currently trying to assess the health implications of portable classrooms. Our 1999 study did not find any negative student performance impacts associated with portables. Indeed, our models tended to find positive, but not statistically significant impacts, associated with being in a portable classroom, once we controlled for daylight, ventilation and all other variables in our equation. To learn more about teacher's perceptions of portables we included a question about preference of portable or permanent classrooms in the survey (Question 16). The answers and associated comments are fully presented in Appendix 7.1.2.

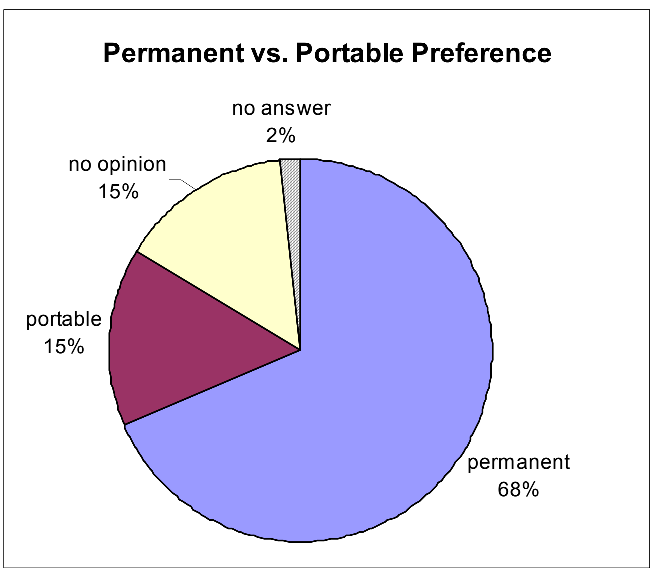


Figure 7: Permanent vs. Portable Classroom Preference

Sixty eight percent of the teachers surveyed preferred to teach in a permanent classroom rather than a portable one. (Figure 7). Thirty percent of the respondents were divided equally between those who preferred portable classrooms or reported no preference for either type.

48% of the teachers that preferred portables mentioned that the closed walls of the portable solved the noise and distraction problems found in the permanent classrooms of their school created by an open classroom plan or poor acoustics. 24% preferred portables because they were larger than the permanent classrooms available at their school. Remaining comments mentioned the presence of air conditioning, better bulletin boards, and better physical condition.

Teachers who preferred permanent classrooms had a much wider range of reasons why. Larger size, better location, better amenities, less noise were frequently mentioned. One teacher summed up a preference for permanent classrooms in the comment: “Feels substantial and lets children know they are important and that things are not temporary.” 22% of teachers preferring permanent classrooms specifically mentioned indoor air quality concerns, such as moldy or musty smells and increased incidence of allergies or colds in portables.

2.2.6 Classroom Energy Management

In the survey, teachers were asked how they operated a number of energy using features in their classrooms. The data that we have for the Capistrano classrooms merely indicates the presence of a feature, such as operable windows, not whether or how it is used. This set of questions was intended to provide insight into how their might actually use these features, and provide some baseline data, admittedly self-reported, that might allow us to estimate the energy impacts of various features.

Figure 8 highlights the percentages of teachers’ responses for the ten energy statements surveyed. Positive percentages indicate actions taken, while negative percentages indicate inability to act, or no action.

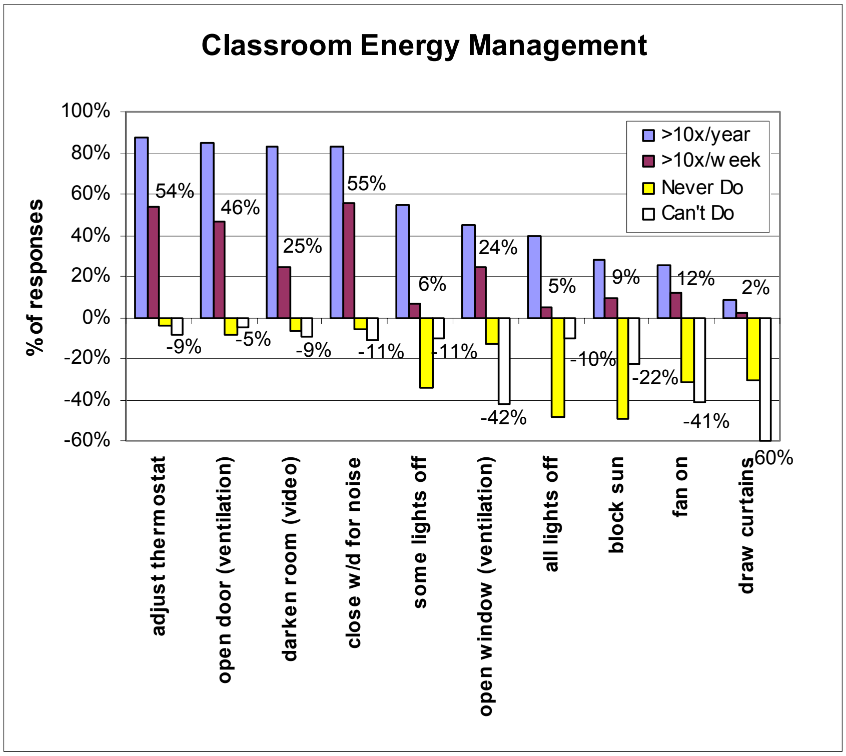


Figure 8: Teachers' Energy Management of Classrooms

HVAC control: Over 50% of the teachers' surveyed reported adjusting the classroom thermostat on a weekly basis, and almost 90% of them reported doing this more than 10 times/school year (about monthly).

Acoustic control: Over 80% of the teachers occasionally close the windows or doors ("close w/d for noise") to avoid high noise levels from the outside, and 55% do this frequently.

Ventilation control: 46% open the outside door for ventilation purposes on a weekly basis and 84% do this at least 10 times every year. 25% of the teachers surveyed reported doing this on a daily basis. More than 40% of the teachers surveyed reported they can't open a window for natural ventilation, while 42% of the total sample open a window at least 10-times/school year. 12% of the teachers report using a portable fan, which probably means they brought in their own personal fan that they purchased themselves to solve a perceived ventilation problem in their classroom.

In the comments section, one teacher summarized the teaching challenges faced with in small, poorly ventilated portable: "The students do not have enough space to move around. Most large projects are eliminated because of lack of space and no access to water. The room is so small that we use the ramp outside to set up centers. The door is always open because the poor circulation in the room gets us sick. We have no water to wash our hands after sneezing and coughing…we get sick more often and pass colds, flu to each other because of our close proximity."

Lighting control: Darkening the room for TV or video is also very common, done by over 80% occasionally and 25% frequently. Turning some or all lights off is also a fairly common activity, while taking measures to block the sun, or close curtains is much less frequent.

Figure 9 shows further detail on teachers' management of the electric lighting in their classrooms. This graph shows 54% of the teachers turning some of the lights off, and 37% of the teachers turning all of the lights off, at various frequencies during the school year.

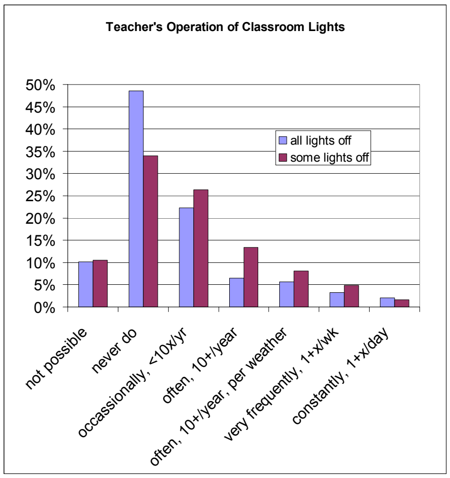


Figure 9: Teachers' Lighting Management of Classrooms

2.3 Conclusions

The results of the teacher survey on preferences and operation of classrooms suggest that daylighting and operable windows are indeed important to teachers, but tend to be secondary to their most pressing concerns, such as adequate size, location, and water (hygiene) availability in classrooms. Acoustic, thermal and visual comfort and adequate ventilation are all frequently listed as top priorities.

The optional comments response to the survey was overwhelming. 98% of the teachers surveyed took the time to write about what was good and bad in their classrooms. The passion put into the comments on physical comfort in classrooms makes it clear that teachers are very stressed by any type of poor physical condition in classrooms where they must work every day with 20-30 very active children. “Please help California get more square footage per child. It’s crazy!” pleaded one. “Teaching … without running water makes me feel like it’s the 1900’s. We carry pails of water!” exclaimed another. One teacher concluded about the need for cross ventilation: “I believe it is good for myself and students to breathe in some fresh air. It helps us all think.” While some teachers report being pleased and comfortable with their classrooms, a sizable group feel they have overwhelming physical challenges in their classrooms that routinely interfere with their ability to teach.

There are clearly some important energy use challenges revealed in the survey that should be carefully considered by school designers and facility managers. In Figure 8 it is clear that Capistrano teachers are actively trying to increase the ventilation of their classrooms by opening doors, opening windows, and adding portable fans. Furthermore, 54% claim to be adjusting the thermostat at least once a week and 55% also claim to be closing windows or doors at least once a week specifically to control noise in the classroom, implying that they had previously opened them, most likely for ventilation. This suggests that teachers' driving desires for good ventilation, thermal comfort and acoustic comfort tend to be in conflict with the options allowed by their physical environment. Increasing ventilation is likely to also increase ambient noise in the classroom and/or reduce thermal comfort. One teacher summarized this problem with the comment: "I like being able to adjust the a/c, heat and ventilation. The down side of this is the a/c unit makes a lot of noise and makes hearing students and teacher more difficult, so you have to raise your voice, ask for repeats or be very stuffy and uncomfortable during oral readings and discussions."

The Capistrano school district is in a relatively mild climate in Southern California, where ambient temperatures are often in the comfort zone, allowing natural ventilation without supplementary heating or cooling. However, even in Capistrano, it is highly probable that substantial energy is wasted running heating or cooling systems while classroom doors and windows are open. Simply improving the efficiency of the heating and cooling systems will not solve this problem. Rather, given teachers' strong desire for more ventilation, classroom design should include systems that allow increased ventilation without increasing energy use for heating or cooling.

Lighting energy use is also an important issue for schools, constituting a large percentage of overall energy use. The provision of daylighting in classrooms only saves energy if electric lights are turned off when not needed, either manually or automatically. The results in Figure 9 suggest that a manual lighting control scheme has an likelihood of being operated by about half of the teachers in a school. This behavioral element should be factored into any proposed lighting control scheme. While automatic systems may be effective more often, their cost-effectiveness should be compared to manual systems that are occasionally operated by 50% of the teachers.

The information in the Capistrano teacher survey is not comprehensive enough to draw any universal conclusions about teacher preferences or behaviors. However, it is strongly suggestive that the physical environment is a key factor in teaching effectiveness, and that teacher preferences for classroom operation need to be given high priority in the design of comfort systems and classroom controls.

3. TEACHER BIAS ANALYSIS

Once the information in the teacher survey was categorized and compiled into a database, we were able to analyze the data for a potential bias in teacher assignment to more daylit classrooms. This task was pursued with a variety of analytic approaches.

3.1 Hypothesis

For this task we set out to test the hypothesis that the higher rates of learning in daylit classrooms might be attributable to "better" teachers being located in more daylit classrooms. For this discussion "better" teachers would be defined as those who are responsible for faster learning rates in their students, as reflected in the rate of progress measured by standardized math and reading tests. Daylit classrooms would be defined by the *Daylight Code* assigned to each classroom in the original study.

3.2 Methodology

In order to study this question we needed to 1.) find a way to identify potentially "better" teachers 2.) determine if the "better" teachers were being differentially assigned to more daylit classrooms and 3.) determine to what extent the magnitude or significance of the daylighting effect would change if information that could predict teacher quality could be included in the model.

Our first step was to define the specific teacher variables to be included in the models, based on the data we had collected in the early Teacher Survey task. In order to do this, we needed to understand the basic structure of educational requirements for a California Elementary School Teacher's credential, along with the hiring and promotional policies of the district. We collected this information from the Department of Education web site, the Capistrano District personnel office, and by interviewing various district administrators.

3.2.1 Teacher Credentials

In discussions with Capistrano administrators prior to the survey, we were told that the District was not hiring teachers with provisional or emergency credentials. Beyond requiring all of their teachers to be certified, the district highly values continuing education for all teachers. A sliding salary scale rewards additional college education. The District also provides opportunities for on-site training classes that are specifically tailored to the curriculum needs of the district.

In the teacher survey we asked teachers to report on their years of teaching in the current school, district, and total; their highest level of education; additional course work or certifications; and special awards or recognition. This information was all self-reported and described in the teacher's own words. We subsequently categorized this information into the eight variable codes described below.

Teaching Experience: We defined the variable of *Log Yrs Teach* as the natural log of the total number of years teaching. By using a natural log we attempted to account for the diminishing effect of additional years of experience reported in the research literature.

Level of Education:

BA indicated any teacher with a bachelors degree. Reported as Teacher 1.

Clear only indicated teachers who had been teaching for 7 years or more, but had not pursued any continuing education beyond that necessary for their professional clear credential. Reported as Teacher 5.

BA Plus indicated teachers who listed college credits beyond the minimum required for certification. Reported as Teacher 2.

MA indicated those with a masters, or doctorate (one case). Reported as Teacher 3.

MA Plus identified teachers with college credits beyond a master's degree. Reported as Teacher 4.

Certification: This variable was used to identify teachers who had received any special certificates or credentials, beyond the minimum required for a California elementary multi-subject credential. Special certificates for Bilingual Education, Gifted and Talented Education, Special Education, etc. were grouped together under one variable. Reported as Teacher 6.

Honors: Many teachers reported receiving special awards, such as Teacher of the Year, or being selected to be mentor teachers. Because responses varied, and because we had little way of measuring how prestigious the awards were, any teacher that reported receiving an award or being chosen to be a mentor teacher was indicated by the *AwarMent* variable. Reported as Teacher 7.

The teacher characteristics variables were added back into the master data set. The surveyed population of teachers represented about 1/2 of the original data set. Thus, for about 1/2 of the student records we added the information characterizing their teacher's years of experience, education level, special certificates or honors. The remainder of the student records were given an indicator variable for no teacher information.

3.2.2 Assignment Bias

Once we had defined the teacher characteristic variables, we looked to see if there were any significant correlations between these teacher characteristics and the daylight conditions in the classrooms in our Capistrano data set. This was our first statistical test for a teacher assignment bias. If we found a strong pattern of correlation between a few teacher variables and a few daylight codes, then it was likely that some types of teachers were being differentially assigned to more daylit classrooms. In this first pass at the analysis we included all of the window related variables, including the daylight code, window code, skylight codes, and operable windows.

The analysis was based on the data collected in the teacher survey, described in the preceding section. We used the data from surveys of 206 teachers. These teachers taught 3,948 of the students included in the original study. To be consistent with the original study, the first pass statistical analysis was carried out at the student level. In other words, each student was been taken to be an observation. Since the number of students per teacher in our data set varied somewhat independently of the number of total students in a classroom, this approach has the effect of weighting the results according to the study population database. Because of the large number of student observations, it also tends to exaggerate the significance of the correlations.

Looking the student level, we found a statistically significant (2-tailed, $p<.10$), correlation among almost all of the variables (see Figure 10). We found no obvious pattern of any variables less likely to have correlations than others. Furthermore, the magnitude of correlation was minor throughout. The strongest correlation, at $p=.01$, was between *Teacher 7* and *Skylight Type B* (a Pearson Correlation of .227), implying that 5% ($.227^2$) of classroom assignments might be explained by this correlation. Nine other combinations had a Pearson Correlation between 0.1 and 0.2 and all others (61%) were below 0.1[1], indicating a very weak magnitude of correlation.

Variable		Daylight	Window	AA Skylight	A Skylight	B Skylight	C Skylight	D Skylight	Oper. Win.
Teacher 1	Pearson Correlation	0.089	0.068	-0.062	0.111	0.026	-0.001	0.015	-0.106
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.012	0.905	0.144	0.000
Teacher 2	Pearson Correlation	0.044	0.020	-0.076	0.048	0.085	-0.041	0.064	0.019
	Sig. (2-tailed)	0.000	0.050	0.000	0.000	0.000	0.000	0.000	0.067
Teacher 3	Pearson Correlation	0.069	0.112	-0.001	-0.021	0.028	-0.018	0.020	0.004
	Sig. (2-tailed)	0.000	0.000	0.914	0.039	0.007	0.082	0.058	0.718
Teacher 4	Pearson Correlation	0.083	0.080	0.109	0.013	0.077	-0.021	-0.025	0.018
	Sig. (2-tailed)	0.000	0.000	0.000	0.218	0.000	0.048	0.015	0.081
Teacher 6	Pearson Correlation	0.066	0.051	-0.026	0.087	0.047	-0.039	-0.035	-0.034
	Sig. (2-tailed)	0.000	0.000	0.011	0.000	0.000	0.000	0.001	0.001
Teacher 7	Pearson Correlation	0.150	0.147	0.056	-0.096	0.227	-0.067	-0.012	-0.030
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	0.000	0.246	0.003
Log yrs teach	Pearson Correlation	0.138	0.171	-0.005	-0.007	0.097	-0.071	0.022	0.015
	Sig. (2-tailed)	0.000	0.000	0.659	0.499	0.000	0.000	0.033	0.143

N= 3948 students

Figure 10- Correlation of Teacher Variables to Daylight Variables, Student level Analysis, Capistrano

[1] The *Teacher 5* variable had not been defined at this time, so was left out of this correlation table.

In a second pass, we also re-calculated the correlations using the 206 teachers as independent observations. Using the smaller teacher population, un-weighted for student population in our data base, presented a more extreme test for significance. Out of the 56 correlations that are reported in Figure 9, ten were judged to be potentially significant with p-values of .10 or less at the teacher level. None of the correlations with the *Daylight Code* were significant. Skylight Type AA did show a pattern of correlations, but with only 5 surveyed teachers in this group, we discounted this as a random result. The most interesting finding was a slight indication that more senior teachers (Log yrs teach) had some influence being assigned to classrooms with larger window areas, operable windows, or skylight types A, and that Teacher 7 (honors) were more likely to be assigned to skylit classrooms type A or B. The magnitude of a possible effect is minimal, with only 1% to 5% of the variation in assignment to these classroom types potentially explained by either of these variables.

We concluded from this exercise that there was indeed some potential for an assignment bias relative to honors or years of experience, but that a two-dimensional correlation analysis was not a sufficient tool to determine its magnitude or influence on the results of the multi-variate regression models.

3.2.3 Decision to Focus on Daylight Code Only

For simplicity sake, we choose to work henceforth with just the *Daylight Code.* Tracking the change in performance for one variable, instead of eight, reduced the complexity of the task dramatically. We choose to focus on the *Daylight Code* since it was the holistic code that combined the effects of the window and skylight codes together. It had been very robust in the previous analysis, and described the classroom characteristic of greatest interest.

By focusing our attention on just the change in the *Daylight Code* across models, we were more likely to see patterns across models.

3.2.4 Daylight Code as a Dependant Variable

Next we ran a regression model with the *Daylight Code* as the dependant, or outcome, variable and the teacher characteristic variables as the independent, or explanatory variables. This model was run using only the surveyed teacher population. This model would tell us more precisely if there was indeed an "assignment bias," such that some teacher types were more likely to be assigned to daylit classrooms. It was a more precise test than the correlation tables, since it allowed the influence of each teacher characteristic variable to be assessed simultaneously.

From this regression model, we found that there were NO teacher characteristics, as defined by our variables from the survey data, that were significant in explaining assignment to more daylit classrooms. The variable that achieved the highest probability of influence was Teacher 7 (honors) at only 78% likelihood of significance (p=.22) that there might be a 5% higher assignment in *Daylight Code* (A teacher who had received an honor or award had a 78%

probability of being assigned to a classroom rated 3.15 on the daylight scale instead of a 3.0). The other variables had a 50% probability or less.

The R^2 for this model was only 0.014, indicating that all of the teacher characteristic variables could explain only 1% of the variation in assignment to daylight classrooms. When we ran a similar model at the student level, the level of explanation increased to 2%. Thus, from this exercise we conclude that the Capistrano Unified School District did not have any marked bias in the assignment of teachers to more daylit classrooms, based on the teacher characteristics that we studied.

3.2.5 Teacher Assignment Bias Models

Our final step in the Teacher Bias Analysis was to re-run the original Capistrano student performance models with the teacher characteristic variables added to the list of potential explanatory variables. Again, we choose to focus our reporting on the results of the *Daylight Code* for simplicity, although we did also run the separate models with the window and skylight variables. The original models were re-run for both change in reading and math scores at the student level. Teacher characteristic variables were added for 42% of the population.

It should be noted that the performance of the observed students within a given classroom may not be mutually independent. In the original research, we carried out a special analysis to assess the effect of correlation between students within a given classroom (See Appendix 6.2 to original report, dated 6/29/1998). This analysis indicated that the statistical significance of some of our results was somewhat overstated but the effects of interest were not substantially altered. However, carrying out the analysis at the student level made it easier to explore the relationship between characteristics of the student, teacher, room, and school.

3.3 Findings

Figure 12 and Figure 11 display the findings of these two models, compared to the original models without the teacher variables. The school site variables and outliers have been left off of the equations shown here for simplicity, but are included in the full model detail in the Appendix 7.2. A central column shows the change in the B coefficient for each variable and the model R^2.

New Model Capistrano, Teacher Analysis - 28-2 (Original population)	Math Daylight			Change new-old	Old Model Capistrano, Original Analysis C17-md	Math Daylight		
				R^2				
Model R^2	**0.259**			**0.003**	**Model R^2**	**0.256**		
	B	Std. Error	p (Signif)	**B**		B	Std. Error	p (Signif)
(Constant)	9.045	0.464	0.000		(Constant)	8.026	0.407	0.000
Classroom characteristics					Classroom characteristics			
Daylight code	0.430	0.072	0.000	**-0.075**	Daylight code	0.504	0.067	0.000
Teacher characteristics								
Teacher 3	-0.933	0.248	0.000					
Teacher 5	-0.688	0.335	0.040					
Log yrs teaching	0.373	0.077	0.000					
Student characteristics					Student characteristics			
Grade 2	9.624	0.216	0.000	-0.088	Grade 2	9.711	0.215	0.000
Grade 3	5.949	0.220	0.000	0.018	Grade 3	5.931	0.219	0.000
Grade 4	1.802	0.216	0.000	-0.011	Grade 4	1.813	0.216	0.000
Absences unverified	-0.263	0.123	0.033	0.000	Absences unverified	-0.263	0.123	0.032
Absences unexecused	-0.029	0.014	0.043	-0.003	Absences unexecused	-0.026	0.014	0.069
GATE program	-1.191	0.222	0.000	0.045	GATE program	-1.236	0.223	0.000
Language program	0.488	0.205	0.017	-0.001	Language program	0.490	0.205	0.017
School characteristics					School characteristics			
School Pop-per 500	-0.995	0.000	0.000	-0.483	School Pop-per 500	-0.512	0.000	0.010

Figure 11 - Change in Capistrano Math Model with Addition of Teacher Variables

New Model Capistrano, Teacher Bias Analysis - 28-2 (Original population)	Reading Daylight			Change new-old	Old Model Capistrano, Original Analysis C17-rd	Reading Daylight		
				R^2				
Model R^2	**0.248**			**0.002**	**Model R^2**	**0.246**		
	B	Std. Error	p (Signif)	**B**		B	Std. Error	p (Signif)
(Constant)	3.009	0.303	0.000		(Constant)	3.025	0.298	0.000
Classroom characteristics					Classroom characteristics			
Daylight code	**0.475**	**0.086**	**0.000**	**0.011**	**Daylight code**	**0.464**	**0.085**	**0.000**
Operable windows	0.650	0.212	0.002	0.007	Operable windows	0.643	0.212	0.002
Teacher Characteristics								
Teacher 3	-0.917	0.288	0.001					
Teacher 5	-1.335	0.388	0.001					
Log yrs teaching	0.221	0.090	0.014					
Student characteristics					Student characteristics			
Grade 2	10.823	0.251	0.000	-0.037	Grade 2	10.860	0.251	0.000
Grade 3	4.368	0.255	0.000	0.069	Grade 3	4.298	0.254	0.000
Grade 4	0.944	0.252	0.000	0.008	Grade 4	0.937	0.252	0.000
GATE program	-1.432	0.257	0.000	0.020	GATE program	-1.452	0.257	0.000
LANG program	0.827	0.239	0.001	-0.011	LANG program	0.838	0.239	0.000

Figure 12 - Change in Capistrano Reading Model with Addition of Teacher Variables

Even with the addition of the teacher characteristic variables into the original models, the daylight variable stayed highly significant in both cases. For the math model, with the outcome variable as the change in fall to spring math scores, the magnitude of the daylight effect decreased slightly.

For the reading model, the magnitude of the daylight effect actually increased. In the case of the reading model, operable windows also remained a significant variable, and also increased slightly in magnitude.

Three of the eight teacher characteristic variables were found to be significant in both models. (While the significant teacher variables here were consistent, they were not consistent in the models using window codes and skylight types as explanatory variables, nor were they consistent in later models that we ran, discussed later.)

With the addition of information about the teachers, the R^2 of the models increased, but only by a tiny amount, increasing their power of explanation by less than 1%.

3.4 Conclusion

Thus, we conclude that the strength of the daylight variable showed in the original analysis was not an inadvertent effect of a "teacher assignment bias." We have shown in the regression model of the *Daylight Code* versus the teacher characteristic variables, that the teacher characteristics captured in our survey only explained 1% of the variation of teacher assignment to daylit classrooms. Furthermore, in the master student performance regression models adding information about teacher characteristics for 42% of the population did not reduce the significance of the daylight variables. As might be expected, the magnitude shifted slightly; in one case down, in one case up.

3.5 Discussion

One potential weakness in the findings above is that we only had teacher characteristic information for less than half of the study population. We decided it would be a good test to re-run the models for just the population of students represented by teachers who responded to the Teacher Survey. That way, we could look at a model where 100% of the population had information about the teachers. This "surveyed population" model included 206 teachers and 3948 students, or about 50% of the original population.

We were aware that if we shifted the sample population for a model, we ran the risk of getting different results. But we wanted to examine the stability of the daylighting coefficient in our models over different sample populations. We also wanted to explore the stability of including the information about the teachers. Thus, we decided to run similar models to the original Capistrano math-daylight and reading-daylight models, looking at the change in the daylight variable from one sample to another and with the addition of the teacher characteristic variables.

We also had one other complexity to account for. In coding the data from the Teacher Survey it was discovered that three schools had been inadvertently dropped from the original study population. Criteria for inclusion of a student's record in the original analysis had included complete records for test scores, attendance and demographic data. We did not observe at the time that we had not been provided with attendance data for three entire schools. Thus, the data cleaning procedures resulted in inadvertently dropping all students (and all teachers) from those three schools from the analysis. We were particularly concerned since two of the dropped schools represented somewhat extreme daylight conditions, one with many classrooms of *Daylight Code 0*, and the other with many Classrooms of *Daylight Code 4*. Thus, we worried that the exclusion of these schools from the original analysis may have skewed our results.

We noted that any effect due the missing attendance data could be absorbed to some degree by the dummy variable that identified the school site that was missing the attendance information. Thus, we decided to create a new "expanded" population that included these three schools and provided a "missing" indicator in the attendance record fields. This "expanded population" model included 394 teachers and 9200 students, 13% larger than the original study population.

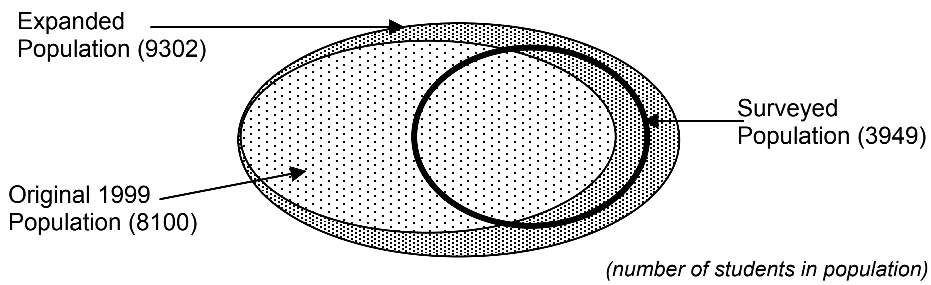


Figure 13: Surveyed, Original, and Expanded Populations

We were interested to see if the daylight variable would remain significant in models of student performance in these different populations, with and without the addition of the teacher characteristic variables. The *teacher survey population* would present the clearest test of the impact of the teacher characteristics, since for this population we would have information about teacher characteristics for 100% of the teachers. The *expanded population* was likely to have the truest daylight results, since it represented the full 2-5 grade district population in 1997/98 school year. For this population we had information on 50% of the teachers.

3.5.1 Findings of Different Study Population Models

Figure 14 and Figure 15 compare the results for the three sets of regression models; the original model, the expanded model, and the teacher surveyed model, for the reading and math models. Full detail of all models is included in the Appendix. In addition to comparing the B coefficient for the *Daylight Code*, the significance of the *Daylight Code* and the R^2 of the model, we also report here on the effective rate of change in the learning rate, and the confidence interval for that rate.

Key	Capistrano Reading Model, Study Population	Teacher Variables Included in Model	B Coefficient for Daylight Code	p (Signif) of B	Model R^2	% Change in Learning Rate	confidence interval
A	original	no	0.464	0.000	0.247	26%	±10%
B	original	yes	0.475	0.000	0.248	27%	±10%
Shift from Model A to B			0.011	no change	0.001	1%	no change
C	expanded	no	0.416	0.000	0.238	24%	±9%
D	expanded	yes	0.418	0.000	0.240	24%	±9%
Shift from Model C to D			0.002	no change	0.002	0%	no change
E	surveyed	no	0.434	0.000	0.239	23%	±12%
F	surveyed	yes	0.463	0.000	0.243	25%	±12%
Shift from Model E to F			0.029	no change	0.004	2%	no change

Figure 14: Daylight Affect for Different Populations, with and without Teacher Variables, on Reading Tests in Capistrano

Key	Capistrano Math Model, Study Population	Teacher Variables Included in Model	B Coefficient for Daylight Code	p (Signif) of B	Model R^2	% Change in Learning Rate	confidence interval
A	original	no	0.504	0.000	0.257	20%	±5%
B	original	yes	0.430	0.000	0.259	17%	±6%
Shift from Model A to B			-0.074	no change	0.002	-3%	1%
C	expanded	no	0.351	0.000	0.250	14%	±5%
D	expanded	yes	0.301	0.000	0.252	12%	±5%
Shift from Model C to D			-0.050	no change	0.002	-2%	no change
E	surveyed	no	0.544	0.000	0.274	21%	±8%
F	surveyed	yes	0.497	0.000	0.277	19%	±8%
Shift from Model E to F			-0.047	no change	0.003	-2%	no change

Figure 15: Daylight Affect for Different Populations, with and without Teacher Variables, on Math Tests in Capistrano

For the reading model, the most conservative estimate of a daylight effect would be +11% for the surveyed population without teacher variables (23%-12%), while the most optimistic would be +37% for both the original and surveyed population with teacher variables (27%+10% and 25%+12% respectively). For the math model, the most conservative estimate of a daylight effect would be +7% for the expanded population with teacher variables (12%-5%), while the most optimistic would be +29% for the surveyed population without teacher variables (27%+10%). Thus, from worst to best case we can say with a high degree of confidence, that children with the most daylighting in Capistrano are learning somewhere from 7% to 37% faster on the District's math and reading curriculum.

With the addition of teacher characteristics to the three sets of models, the following changes were observed:

- Daylight variables were still significant across all models
- R^2 value increased by 0% to +2% indicating that the models with teacher characteristics had a slightly better explanatory power for the studied phenomena.
- Math models indicated a decrease in the effect of daylight on student performance by 2% to 3%.
- Reading models indicated an increase in the effect of daylight on student performance by 0% to 2%.
- In general the availability of daylight in classrooms was reliably associated with an increase in student performance and learning rate of somewhere within the bounds of 7% to 37%. The central tendency among all these models would seem to be a 25% improvement in reading and a 16% improvement in math, or a 21% general improvement between children in classrooms with the most daylight (code 5) compared to those in classrooms with the least (code 0). In summary, if the average student in the district were moved from an average classroom (code 2.5) to a classroom with maximum daylight (code 5), he or she would be expected to increase his or her learning rate by 11% (10.5).
- All these results were observed with 99.9% statistical certainty.

In addition, we were interested to understand the change in daylighting effect among the three populations, the original, expanded, and surveyed, before the addition of the teacher variables. Figure 16 and Figure 17 compare the changes when moving from the original population to the expanded population (13% larger), and from the original to the surveyed (50% smaller) for both reading and math. These changes were also very modest, with from a 3% to 6% shift in the net impact of the daylight variable on student learning rates.

Key	Capistrano Reading Model, Study Population	Teacher Variables Included in Model	B Coefficient for Daylight Code	p (Signif) of B	Model R^2	% Change in Learning Rate	confidence interval
A	original	no	0.464	0.000	0.247	26%	±10%
C	expanded	no	0.416	0.000	0.238	24%	±9%
Shift from Model A to C			-0.047	no change	-0.009	-3%	-1%
A	original	no	0.464	0.000	0.247	26%	±10%
E	surveyed	no	0.434	0.000	0.239	23%	±12%
Shift from Model A to E			-0.030	no change	-0.008	-3%	2%

Figure 16: Teacher Variables and Daylight effect on Reading for the Three Populations Compared

Key	Capistrano Math Model, Study Population	Teacher Variables Included in Model	B Coefficient for Daylight Code	p (Signif) of B	Model R^2	% Change in Learning Rate	confidence interval
A	original	no	0.504	0.000	0.257	20%	±6%
C	expanded	no	0.351	0.000	0.250	14%	±5%
Shift from Model A to C			-0.153	no change	-0.007	-6%	-1%
A	original	no	0.504	0.000	0.257	20%	±6%
E	surveyed	no	0.544	0.000	0.274	21%	±8%
Shift from Model A to E			0.040	no change	0.017	1%	2%

Figure 17: Teacher Variables and Daylight effect on Math for the Three Populations Compared

Interestingly, the greatest variability between models, 6%, occurred from the original to expanded populations for the math model. Earlier, in the Classroom Level Analysis, included in the Appendix of the 1999 Detailed Report, we had found much greater variability in the success of math instruction attributable to individual teachers than reading instruction. Thus, we would also expect greater volatility in the math results between population samples.

The following findings were observed when comparing the three populations before adding the teacher variables to them:

- No change in significance of daylight variable
- The explanatory power of the statistical models (i.e., R^2) in explaining the data varies by less than 2%.

3.5.2 Conclusions of Different Study Population Models

The shift in model study populations actually had a greater impact on the R^2 of the models than the addition of the teacher characteristic variables. We also saw the largest shift in the magnitude of the B coefficient for the *Daylight Code* between study populations, rather than with the addition of information about the teachers. Thus, we conclude that the selection of the study population is more likely to impact findings about the effect of daylight than is the addition of information about teachers.

We continue to believe in the importance of the addition of the teachers' characteristics to the model, both to access the potential for a teacher bias and to further refine the accuracy of the model. However, it is clear from this exercise that the study population is likely to have an even greater effect on the results. This once again argues for the importance of replicating the study in other districts, and preferably in widely differing geographic regions and cultural environments.

4. GRADE LEVEL ANALYSIS

The Grade Level Analysis task was intended to answer two of the questions that were raised from a previous peer review[1] of the Daylighting in Schools study.

One question was whether it was might be more appropriate to analyze the data in single grade cohorts, rather than across grades. It was proposed that especially in Seattle, for the Iowa Test of Basic Skills (ITBS), results could not correctly be compared across grades. Creating separate models for each grade level would solve this problem.

A second question asked whether the daylighting effect might vary by grade level. The models used in the first analysis constrained the results to a simple linear expression. It was argued that there might be a progressive effect, again especially in Seattle, where children were exposed to fairly consistent daylighting conditions for the duration of their career at a given school. In Seattle, where we were looking at absolute test scores, exposure to good daylight conditions over more than one year might result in a cumulative effect. This would be evidenced by a progressively greater daylight effect in each higher grade. Again, separate grade level models would allow the daylight effect to change by grade level, allowing us to identify any patterns as children got older.

In Capistrano, we hypothesized that we would not find any progressive effects since children are likely to be shuffled back and forth between traditional classrooms and portable classrooms with each change in grade level. We confirmed with the District that the churn rate in the Capistrano district is reasonably low, with about 4% growth per year, and a similar number of students who relocate to other districts per year. Thus, we estimate about 90% of the students return to a given school each year. Typically, they would experience at least two, if not three or four daylight conditions throughout their career at a given school. Furthermore, since in Capistrano we were looking at the improvement in schools in one year, from fall to spring, cumulative effects would be less likely to show up.

4.1 Hypothesis

Given the main objective of this task, it was hypothesized that daylighting may have a cumulative effect on student scores. This hypothesis would be likely true if a pattern of progressively stronger effects by grade level was observed in Seattle, where children typically remain under one school-wide daylighting condition. A comparative analysis for the test scores in the Capistrano school district, where students may change between high and low daylighting conditions

[1] Daylighting and Schools Peer Review Report, sent to PG&E, July 21, 1999. Not released.

during their stay at an elementary school, would corroborate our hypothesis if a minor or no cumulative effect of daylight was observed in that district.

4.2 Methodology

We re-ran the student performance regression models for both Seattle and Capistrano, this time allowing the daylighting effect to vary by grade level. This was achieved by adding grade level interaction variables for each variable in the model. This is statistically equivalent to running separate models, but simplifies the reporting and interpretation.

Interaction variables between the grade level of the student and each explanatory variable were created and added to the original Capistrano and Seattle models. As in the original study, the Capistrano model used the difference between fall and spring scores while Seattle's used the absolute value of the spring scores.

Since information regarding teacher characteristics was available for the Capistrano school district, the teacher variables were also included in the Capistrano math and reading models to strengthen their explanatory power.

4.3 Findings

The data from our interaction models did not show a significant effect for the interaction variables between daylight and separate grade levels. This indicates that, for our study populations, we could not support the hypothesis that daylight has a different or cumulative effect on student performance by each grade. The full model results are shown in the Appendix 7.3.

We also found that allowing the results to vary by grade did <u>not</u> improve the accuracy of the models. The R^2 of the models increased only very slightly with the addition of the interaction variables, 4% for the Seattle reading model, and less than 1% for the other three. (See Figure 18 and Figure 19)

It is important to note, however, that the daylighting effects remained highly significant even after the addition of the interactive variables. This indicates that daylight still provides a robust explanation of student performance in math and reading tests across all grades. For the Capistrano reading model, the magnitude of the effect (B) declined by 14%, but not the significance.

For the Capistrano math model, we saw a greater impact on both the magnitude (45% decline) and significance (7% decline). This is the one incidence where the daylight variable would not pass our threshold criteria of 95% significance or greater for inclusion in the model. This decline in significance and magnitude were probably caused most by the addition to this model of the one daylight-grade level interaction variable that did prove significant: *Daylight Code(2nd grade)*. This interaction variable was found to increase the daylight effect considerably for second graders, by more than twice (216%). The interpretation here would be that second graders in more daylit classrooms were mastering the math curriculum dramatically faster then those who were not in daylit classrooms, and also comparatively faster than children in other grade levels in daylit classrooms.

While this finding about second graders learning math might seem potentially interesting, the fact that we did not find any other significant interaction effects in any of the other model tends to discount the validity of this finding. Out of twelve opportunities, the interaction between grade level and daylight was found to be significant in only one case. Thus, we tend to doubt that there is any differential sensitivity to daylight by grade level.

Key	Test	Interactive Variables	B	Model R^2	% impact	error bound	Signif.
A	Reading	N	0.464	0.247	26%	+/-10%	100.0%
B	Reading	Y	0.396	0.239	22%	+/-9%	100.0%
Shift from Model A to B			-14%	-0.008	-4%		0%
C	Math	N	0.504	0.257	20%	+/-5%	100.0%
D	Math	Y	0.275	0.261	11%	+/-12%	92.7%
Shift from Model C to D			-45%	0.004	-9%		-7%

Figure 18: Capistrano Grade Level Models with Interactive Variables Summary

In Seattle, when allowing for grade level interactions with all the other variables, we saw no declines in significance, and also saw substantial increases in the magnitude of the daylight effect. In the case of the Seattle reading model, the magnitude of the daylight effect increased 26%, while in the math model the magnitude of the daylight effect increased 12%. For the Seattle reading model, the accuracy of the model (R^2) increased 4%. This would tend to argue for the validity of the increase in the magnitude of the daylight effect. Since some of the significant interaction variables have to do with the physical conditions of the classroom (school vintage, school size, classroom SF) it is possible that some of the daylight effect was previously being masked by the imprecision of those variables without the interaction effects.

Key	Test	Interactive Variables	B	Model R^2	% impact	error bound	Signif.
A	Reading	N	1.883	0.297	16%	+/- 8%	100.0%
B	Reading	Y	2.533	0.337	22%	+/- 7%	100.0%
Shift from Model A to B			26%	0.040	6%		0%
C	Math	N	1.391	0.258	12%	+/- 7%	99.9%
D	Math	Y	1.585	0.257	13%	+/- 7%	100.0%
Shift from Model C to D			12%	-0.001	2%		0%

Figure 19- Seattle Grade Level Models with Interactive Variables Summary

4.4 Conclusions

The grade level analysis did not increase the accuracy of the models. Further more, while we did find interaction effects between grade level and other variables, most notably the demographic variables, we did not find a consistent interaction between grade level and a daylighting effect. This was true in both Seattle and Capistrano.

From this exercise, we conclude that our original modeling approach, grouping all of the data for grades 2-5, was sufficiently accurate. We also note that we did not find any progressive effect for the daylighting variable, as postulated for Seattle, nor any other pattern related to the age of the student.

5. ABSENTEEISM ANALYSIS

The Capistrano data set includes information on absences and tardiness per student. Both of these parameters were included as explanatory variables in our original daylighting analysis, but not as dependant variables. We did not use them as dependant variables at the time for two reasons. First, we did not have this information for all three districts, and our original criteria included consistent analysis across districts. Second, the absenteeism and tardiness data is much thinner than student test performance data, since only about 10% of students had a significant number of absences. Thus, it provided a much less sensitive metric of performance.

However recent research findings by others, discussed below, suggested that we should re-examine the Capistrano data set for similar effects. In a number of studies increased ventilation rates have been found to reduce worker absenteeism. There has also been increased interest in the effect of classroom environments, particularly portable classrooms, on student health with a number of epidemiological studies initiated to look for these links. Finally, many daylighting proponents have been claiming the daylighting improves student attendance, and thereby will also increase funding to the schools through California's system of ADA (average daily attendance) payments.

Milton et al of Harvard School of Public Health reported that increased ventilation rates were associated with reductions in sick leave in the Polaroid Company offices in Massachusetts[1]. They report: "Based on this latter analysis, 45% of the sick leave among workers in lower ventilation areas was attributable to lower outdoor air supply. Similarly, 41% of sick leave was [also] attributable to humidification, and 39.2% of sick leave…was attributable to the presence of (IAQ) complaints. This corresponded to 1.4 – 1.5 days of increased sick leave per person per year attributable to ventilation, and 1.2 – 1.3 days per person per year attributable to humidification, and 1.1 – 1.2 days per person per year attributable to IAQ complaints, depending on age and gender."

Teculescu et al. [2] recently reported that occupants of an air-conditioned building were more likely to have multiple absences from work than were persons in a naturally ventilated building. This study was limited, however, by the use of only two buildings (in northeastern France), and by lack of control for ventilation rates and individual and group factors that may have confounded the relationship between building and sick leave.

[1] Milton DK, Glencross PM,Walters MD. Risk of Sick Leave Associated with Outdoor Ventilation Level, Humidification, and Building Related Complaints, Harvard School of Public Health, August 1999

[2] Teculescu DB, Sauleau EA, Massin N, Bohadana AB, Buhler O, Benamghar L, Mur JM. Sick-building symptoms in office workers in northeastern France: a pilot study. Int Arch Occup Environ Health 1998; 71:353-6.

The interest in the effect of classroom construction and maintenance, particularly portable classrooms, on student health has peaked in recent years. Current projects in progress include: HP-Woods Institute is studying the relationships between indoor environment and occupant performance in two elementary schools, funded by Air Conditioning and Refrigeration Technology Institute's 21-CR program; the California Department of Public Health is beginning a study of the environmental health conditions in portable classrooms, funded by Air Research Board; a pilot study of indoor air quality in portable classrooms is being done in Los Angles Count, funded by US EPA; another CEC PIER project is also looking at exposure to VOCs and thermal comfort in four new portable classrooms.

Given this level of interest, we concluded that it would be worthwhile to see if our original Capistrano data set would allow us to make any correlations between classroom physical conditions and student health. The absenteeism and tardiness data could be used as a proxy measure of student health, while daylighting, operable windows, air conditioning, age of classroom and type of classroom (portable, modular, open, semi-open, traditional) could be used as explanatory variables.

We choose to look at absences or tardies data as a reasonable potential proxy for student health. However, our study could not distinguish reasons for absences or tardies. There are many other powerful factors influencing elementary school attendance besides the health of the student, such as dentist or orthodontist appointments, outside activities, poor transportation, parental health, family obligations, etc. Thus, our absenteeism and tardiness variables cannot be interpreted as a strong metric of student health, but rather simply as the best proxy for student health that we had available in our data set.

5.1 Hypothesis

In our earlier Capistrano study, we found that daylight was consistently associated with enhanced learning rates, and operable windows were associated (>95% certainty) with enhanced learning rates in three of the four models. In that original analysis, neither portable classrooms nor the presence or type of air conditioning had a statistically significant effect.

Based on this finding we hypothesized that daylighting and operable windows might also be associated with a reduction in student absenteeism and tardiness in the Capistrano school district.

If this hypothesis were true, operable windows and daylight, as explanatory variables, would appear to be significant and negative in a regression analysis with student absenteeism and tardiness as dependant variables.

Since the models also included other descriptions of the physical conditions of classrooms, we could simultaneously test for the significance of those variables in relationship to absenteeism or tardiness. We were particularly interested in the portable classroom (port) and modular classroom (pport) variables. If portable or modular construction does indeed impact student health, then we would expect to see these variables show up as significant in the regression analysis.

5.2 Methodology

A multivariate regression model, using the original data from the 1999 study of the Capistrano school district with all the school data, including daylight, operable windows, as well as the addition of the new teacher and school variables, was run. The student characteristics, teacher characteristics, and school and classroom characteristics were run as independent exploratory variables against absenteeism data the dependant outcome variable. A similar model was run with the same variables against tardy data as an outcome variable.

The data set was redefined to include all those students who attended at least 40 days at the same school. The students, however, were not required to have test scores. As a result, the population shifted slightly, including more students who were not present for either the fall or spring tests, but excluding any records missing attendance data. Thus, the three schools from which we had never received attendance data were dropped from the population. The resulting analysis population was 8808 students.

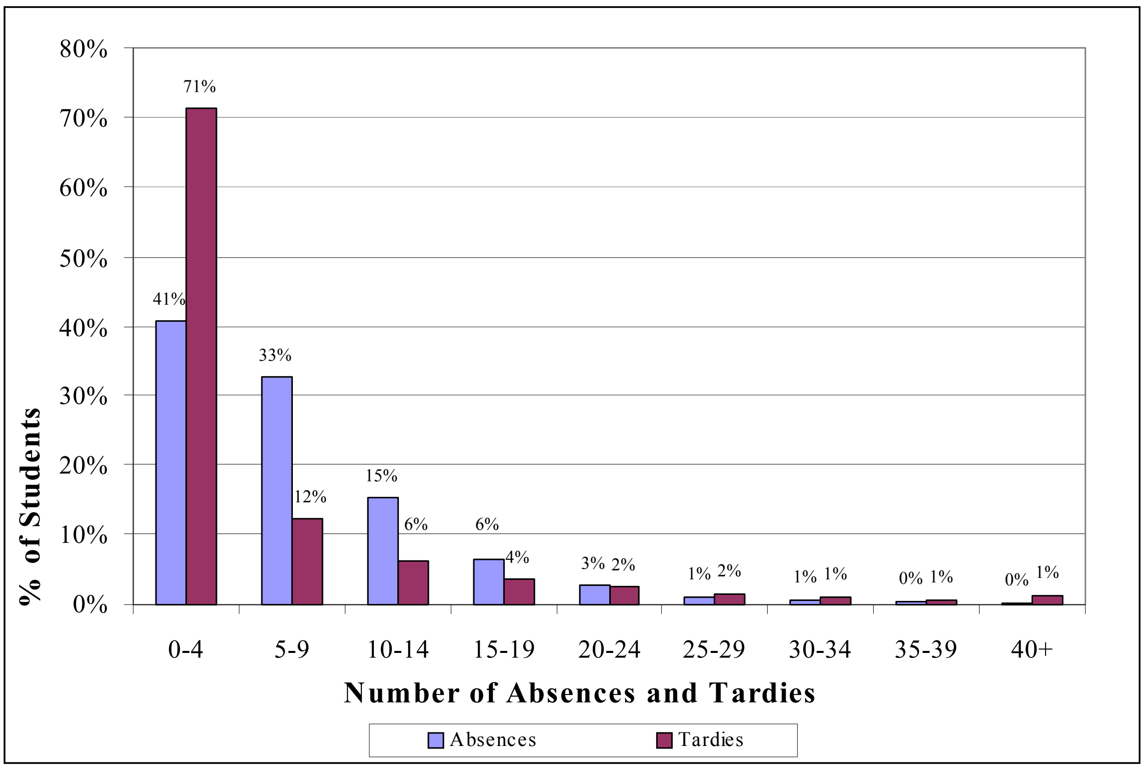


Figure 20- Distribution of Absences and Tardies

The absence variable was defined as a function of the sum of three fields in our data set: unverified absences, excused absences, and unexcused absences.

Absences due to school function were not included. Only the sum of absences per student was available. We did not have information on the distribution of absences over time.

Plotting the attendance data in Figure 20 we noted a very strong curve, where 74% of the population were found to have both fewer than 10 absences, and 83% fewer than 10 tardies. In order to properly model this data distribution we choose to use a natural log function, as expressed in the equation shown in Figure 21 below. We normalized the absenteeism and tardiness data across the whole population by adding a ratio of days enrolled to maximum possible days enrolled:

$$\text{Ln\_Abs} = \ln\left[\frac{180\text{ (maximum of enrolled days)}}{\text{number of days enrolled (minimum} = 40)}\times\text{number of Absences (or Tardies)}\right]$$

Figure 21- Equation for natural log of attendance data

5.3 Findings

The regression models with the log of absences or tardiness as dependant variables did NOT support the hypothesis that daylight variables, or any other physical characteristics of the classrooms, have a significant effect on student absenteeism or tardiness.

While these models included all of the same explanatory variables used in previous analysis, they proved to be comparatively weak models. The R^2 of the absences model was only 0.05, and that of the tardiness model 0.10, indicating that only 5% and 10% respectively of the variance in the data was explained by all of the variables included in the models.

5.3.1 Absenteeism Findings

Physical classroom variables that were considered and found to have NO significance in the absenteeism model included: daylight code, operable window, type of classroom (portable, open, traditional), air conditioning, and size of classroom. In addition, none of the teacher characteristics were found to be significant.

Variables that were significant included: grade level, student socio-economic characteristics, special programs, school site, school vintage, and school population.

Thus, we conclude that student demographic characteristics and school level characteristics (which might include neighborhood effects, special programs, or size of school) have the greatest relationship to student absenteeism.

5.3.2 Tardiness Findings

The Tardiness model did find that three physical characteristics of classrooms had a slight, significant effect on the pattern of tardiness:

- Daylighting had a modest, positive effect p=.000
  - 5% reduction
- No Air Conditioning had a slight, negative effect p=.032
  - 11% increase
- Portable classrooms had a slight, negative effect p=.037
  - 5% increase

R^2 = 0.097

These results could be interpreted to predict that the students in the most daylit classrooms would be likely to have one less tardy per year than those in the least daylight classrooms (5 daylight codes *.05 per code =25% reduction in norm of 5 tardies per year, or 4 tardies per year.) Likewise, no air conditioning was found to be associated with a slight increase in tardiness, 11% from the norm of 5 to 5.5 tardies per year, and portable classrooms were found to be associated with a slight increase in tardiness by 5%, up to 5.25 tardies per year. .

Since tardies are a somewhat subjective measure of student performance (not all teachers mark a student tardy at the same point of lateness) and since tardies do not have as a strong economic tie to the performance of the school as does absenteeism data, we chose to discount these results as not particularly interesting.

5.4 Conclusions

Student attendance, as measured by absences and tardies, was not predicted by with the daylight conditions of the classrooms in the Capistrano Unified School District. Likewise, other physical conditions of the classrooms were not found to be reliable predictors of student attendance.

From this exercise, we concluded that attendance data is a very difficult outcome metric to work in trying to understand the effects of the physical environment on the performance of students, or the productivity of people in general. There are two basic reasons for this difficulty. First, attendance data can only be a loose proxy for the health of the student, since so many other events can cause a student to be absent or tardy besides health effects caused by the physical environment. Secondly, it is not a very sensitive metric. There is not a very big range in attendance values among students, with only about 10% of the student population showing much variation in number of days absent or tardy.

A summary of the findings from the absenteeism analysis is as follows:

- Daylighting variables were <u>not significant</u> indicators of Absenteeism. Similarly neither operable windows nor portable classrooms variables were significant.
- Student demographic variables were the only reliable predictors of absenteeism
- Physical characteristics of classrooms <u>were not predictors</u> of student attendance
- Attendance data is not particularly useful as a performance metric, providing meaningful variation for only 10% of students in our fairly large samples (n= ~ 8800).
- A slight effect of daylight on student tardiness was observed, but not considered interesting.

5.5 Discussion

Our study could not distinguish reasons for absences or tardies. It was assumed that overall absence and tardy data might serve as a reasonable proxy for student health. However, there are many other powerful factors influencing elementary school attendance besides the health of the student, such as dentist or orthodontist appointments, outside activities, poor transportation, parental health, family obligations, etc. Thus, our absenteeism and tardiness variables cannot be interpreted as a strong metric of student health, but rather simply as the best proxy for student health that we had available in our data set.

Improved physical conditions in a workplace or school have been postulated by many to be associated with reduced absenteeism. Indeed, this is a fairly common assertion made in presentations advocating “green” or “sustainable” buildings—that an improvement in the quality of the physical environment will result in fewer absences and thus higher productivity. These claims are most frequently made for improvements in indoor air quality (IAQ)[1], but also variously for natural ventilation, ventilation rates[2], thermal comfort, ergonomic furniture, electric lighting quality and the presence of daylight.

Our study can only speak to a few of these issues: the potential link between poor indoor air quality in portable classrooms and increased absenteeism. It is important to note that this re-analysis study of the Capistrano data did not substantiate any of these claims.

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[1] Fisk WJ (2000). Health and productivity gains from better indoor environments and their relationship with building energy efficiency. Annual Review of Energy and the Environment 25(1): pp. 537-566

[2] Milton DK, Glencross PM, Walters MD (2000). Risk of sick leave associated with outdoor ventilation level, humidification, and building related complaints. Indoor Air, 10(4): pp. 212-21

- Portable classrooms are currently under investigation by a number of researchers for poor indoor air quality[1], which might reduce overall student health.
  - Our study did not find that there was any significant association between portable classrooms and increased absenteeism among students.
- Operable windows have been associated with a reduction in indoor air quality complaints[2].
  - We did not find that operable windows were significantly associated with any improvement in attendance among elementary school students.
- Claims have been made that daylit schools are associated with improved attendance among students[3].
  - We did not find that increased daylight in classrooms was associated with better attendance.

[1] Per Jed Waldman, CA Department of Public Health

[2] MP Callahan, DS Parker, WL Dutton, and JER McLivaine, 1997. “Energy Efficiency for Florida Educational Facilities: the 1996 Energy Survey of Florida Schools.” FSEC-CR-951-97, Florida Solar Energy Center, Cocoa, Fl.

[3] M Nicklas and G Bailey, “Analysis of the Performance of Students in Daylit Schools,” Proceedings of the American Solar Energy Society, 1997.

6. RE-ANALYSIS CONCLUSIONS

6.1 Grade Level Analysis

The data did not show a significant effect for the interaction variables between daylight and separate grade levels. Likewise, we did not observe any consistent patterns of an increase or decrease in daylight effects by grade level. Thus, we conclude that there do not seem to be progressive effects as children get older, nor do younger children seem to be more sensitive to daylight than older children.

Allowing the results to vary by grade did not improve the accuracy of the models; with one exception, the R^2 of the models increased less than 1%. Therefore, we believe that the extra analysis did not add significantly to our understanding and future research can proceed looking at data across grade levels.

Furthermore, the daylighting effects remained highly significant even after the addition of the interactive variables. This indicates that the *Daylight Code* still provides a robust explanation of student performance in math and reading tests across all grades.

6.2 Absenteeism Analysis

The student attendance record regression models did not support the hypothesis that daylight variables or any other physical characteristics of the classrooms have a significant effect on student absenteeism or tardiness. Notably, daylighting conditions, operable windows, and air conditioning were not significant in predicting absences. The models were comparatively weak; the full set of 57 variables for the Capistrano data explained only 5% and 10% of the variance in absences and tardies, respectively.

We chose to look at absences and tardiness data as the best proxy for student health that we had available. Absenteeism and tardiness cannot be interpreted as a strong metric of student health, since many other powerful factors influence elementary school attendance. However, to the extent that attendance data does reflect student health, our study may indicate only a weak connection between physical classroom characteristics and student health.

6.3 Teacher Survey

Although the Teacher Survey task was primarily aimed at providing additional information for other Re-analysis tasks, we did learn some useful information about teacher preferences, attitudes and behaviors. For example, while the teachers we surveyed clearly had a preference for windows, daylight and views in their classrooms, these preferences were not likely to be driving classroom selection. Far more important in classroom selection was an almost universal desire for large classrooms, lots of storage and water supply in the classroom.

Environmental control is also an important issue for teachers, especially when they find that they don't have it in their classroom. Teachers seemed to hold a basic expectation that they would be able to control light levels, sun penetration, acoustic conditions, temperature and ventilation in their classrooms. When control of one or more of these environmental conditions was not available to them in the classroom, they were passionate and outspoken in their outrage.

We also found that teachers reported using their optional control features frequently enough to make significant impacts on classroom energy use. Use of these features by a dedicated minority would seem to be sufficient to justify their cost effectiveness in terms of energy savings. Of course, their value should also be considered in terms of classroom comfort and productivity.

In their freely offered comments, the teachers were desperate to be heard about the need for better physical environments in their classrooms. It is worth taking the time to review these comments included in the Appendix. Class-size reduction, in particular, has been responsible for many of their current challenges. The teachers clearly resent the many inconveniences posed by sub-optimal classrooms. Capistrano is a well-managed school district with many beautiful new facilities, a mild climate and a world-class location on the Southern California coast. Imagine what kind of responses might come from a district facing far more extreme physical challenges!

6.4 Bias Analysis

We did find that a few types of teachers, those with more experience or honors, were slightly more likely (1% to 5%) to be assigned to classrooms with larger window areas, skylights or operable windows. However, a full multivariate regression of teacher characteristics against the *Daylight Code* found that none of the teacher characteristics that we identified were significant in explaining assignment to daylit classrooms. This model explained only 1% of the variation in assignment to daylit classroom. We concluded that this assignment bias, while it does exist, is extremely small.

Similarly, we found that the daylight variables remained highly significant in the student performance models, even after the addition of information about the teachers. While a few teacher characteristics did show up as significant variables in our models of student performance, the daylight variables remained extremely robust in all models.

Comparing across twelve different models of student performance in Capistrano, we conclude that the central tendency is for a 21% increase in learning rate between children in classrooms with minimal daylight compared to those with maximum daylight.

6.5 Re-Analysis Report

Overall, the strength of the daylight variable in predicting student performance stands out sharply across all of these re-analysis efforts. The addition of more information to the models did very little to change the predicted impact of the *Daylight Code* on student performance.

Only the exercise to link the *Daylight Code* to student attendance was unsuccessful. This is also an extremely important finding, since it contradicts so many claims have been made about the health effects of daylight or other indoor environmental conditions, as reflected in absenteeism rates of building occupants. In this study, in this school district, we did not find that any of the physical attributes that we had available to us to classify the classrooms could be linked significantly with student attendance.

It is also very clear from these efforts, as we re-analyzed the original data sets with additional information, that the findings of these models are much more strongly dependant upon the particular population studied in the analysis than upon the subtleties of all the variables included in the models. Thus, we conclude that it will be much more informative to try to replicate this study with a completely different population, at a different school district, such as we will attempt to do in Task 2.4 of this project, than it would be to continue to try to refine the models and with further detail in the explanatory variables. This process has been informative as a sensitivity analysis and methodological study. We look forward to applying these lessons in the next study.

7. APPENDICES

7.1 Statistical Terminology

The following briefly describes key statistical terms in the report.

Table 1

Term	Name	Definition
r	Correlation Coefficient *Or* Pearson correlation	Measures the strength of the linear relationship between two variables It can take on the values from -1.0 to 1.0, where -1.0 is a perfect negative (inverse) correlation, 0.0 is no correlation, and 1.0 is a perfect positive correlation. On page 6, r is the correlation between well-qualified teachers, and student performances. When $.61 < r < .80$, a strong positive relationship is predicted.
p	p-value	A p-value is a measure of how much evidence you have against the null hypothesis, i.e. that the hypothesis is not true. (In the report on page 6, the null hypothesis could be interpreted as: r=0). The smaller the p-value, the more evidence you have. (On page 6, a very small p-value indicates that one has very high evidence that the given correlation is significantly different from 0). The probability of a false rejection of the null hypothesis in a statistical test is called the significance level. A p-value can vary from $>.00$ to <1.0. The significance level is 1-p, expressed as a percentage. So if a p-value is .01, the significance level is 99%. One may combine the p-value with the significance level to make a decision on a given test of hypothesis. In such a case, if the p-value is less than some threshold (usually .05, sometimes a bit larger like 0.1 or a bit smaller like .01) then you reject the null hypothesis.

Term	Name	Definition
R^2	Regression correlation coefficient	A value between 0 – 1.0 that indicates how well an X value (or the independent or explanatory variables in the regression) explains a Y value (the dependent variable). Technically, the regression equation is: $Y= B_0+B_1X_1+ B_2X_2+\ldots+ B_nX_n+e$ where B_0= intercept, e=error, so as Xs change, Y, the dependent variable, also changes., and variations in X values cause variations in Y. R^2 is defined as the percentage of total variation in Y explained by the independent variables. If R^2 is equal to 1, then entire variation in Y is explained by the independent variables, i.e. the model is very good, and the X variables have perfect explanatory power (for explaining Y). So, the higher the value of R^2, the better the model is for that set of data. Models explaining data that have a high degree of inherent variation, such as individual behavior, will have a much lower R^2 than models explaining more predictable events, such as group averages.
B	B Coefficient	Technically, the regression equation is: $Y= B_0+B_1X_1+ B_2X_2+\ldots+ B_nX_n+e$ where B_0 is the intercept (constant), and B_1 ,B_2 ,…,B_n are the slopes of the regression equation, or the coefficients of the Xs, (or the independent variables), and e is error. A particular B_i (i=1,2,…,n) shows how a particular X_i variable is related to Y. If a B_i coefficient is a positive number, an increase in X_i by one unit increases Y by the amount of the B_i coefficient. Please refer to Figure 11 for a list of the B coefficients for each independent variable.

7.2 Teacher Survey

(format changed slightly to fit two pages in this appendix

CLASSROOM SURVEY

Dear CUSD Teacher,

The Heschong Mahone Group, an architectural consulting firm, has been working with the Capistrano Unified School District on an innovative study of the relationship of the physical classroom environment and student performance. We have been funded by the California Energy Commission to do a follow up study to examine a few methodological questions. To do this, we need your assistance to collect information about CUSD teachers and their classrooms.

Please fill out this brief two-page questionnaire and return it today. All individual responses will remain strictly confidential, and will not be released to the District, or to anyone outside of our immediate research team. Only summary data will be reported.

Thank you for your help!

Lisa Heschong, Partner, Heschong Mahone Group

A. Please tell us about yourself:

1. Your Name:____________________________ Grade Level: __________
2. Your current room number (location): _________ 99/00 School: __________
3. How many years have you been in this classroom? _________

   (answer questions 4 and 5 below if you have moved your classroom in the past three years)

4. Your room number from **2** years ago (97/98): _________ Grade Level: __________
5. How many years in that **(97/98)** classroom? _________ 97/98 School: __________
6. How many years have you been teaching at this **school**? __________
7. How many years have you been teaching in this **district**? __________
8. How many years have you been teaching **total**? __________
9. Your Gender: Male ☐ Female ☐
10. Your Age: 20-39 ☐ 40-59 ☐ 60+ ☐
11. Your College Degrees: ____________________________________
12. Additional Coursework:____________________________________

    ____

13. Teaching Awards: ______________________________________

B. Please tell us about your classroom:

14. Do you feel that you had any influence on the selection of your classroom location?

This past year:	Yes	☐	No	☐	Maybe/not sure	☐
When I first started here:	Yes	☐	No	☐	Maybe/not sure	☐
Anytime in between:	Yes	☐	No	☐	Maybe/not sure	☐

15. If you *could* select your own classroom, what would be the three most important criteria you would use to choose? If possible, put them in rank order (1,2,3)

____

____

____

16. Do you prefer teaching in a permanent or portable classroom?

Permanent classroom: ☐ Portable classroom: ☐ No opinion: ☐

Why? ____

17. In general, while school is in session, how often do you:

		Never					Always
*(*Please use the scale described below:)*	**N/A**	**0**	**1***	**2***	**3***	**4***	**5**
Open a window for ventilation	☐	☐	☐	☐	☐	☐	☐
Open a door for ventilation	☐	☐	☐	☐	☐	☐	☐
Close a door or window to reduce noise	☐	☐	☐	☐	☐	☐	☐
Turn on a portable fan	☐	☐	☐	☐	☐	☐	☐
Adjust the thermostat	☐	☐	☐	☐	☐	☐	☐
Teach with the curtains or blinds closed	☐	☐	☐	☐	☐	☐	☐
Teach with all the electric lights off	☐	☐	☐	☐	☐	☐	☐
Teach with some of the lights off	☐	☐	☐	☐	☐	☐	☐
Darken the room for TV or computer use	☐	☐	☐	☐	☐	☐	☐
Do something in order to block the sun	☐	☐	☐	☐	☐	☐	☐

N/A This is not possible in my current classroom

0. I could do this in my room, but I never do
1. I do this occasionally, a few days a year
2. I do this often, more than 10 times per year, depending on the weather
3. I do this often, more than 10 times per year, independent of the weather
4. I do this very frequently, about once a week or more, all year
5. I do this about once a day or more, all year

18. Any comments?

____

____

Thank you very much for your time!
If you have any questions about this survey, please contact Lisa Heschong at the address below.

7.2.1 Three Most Important Criteria in Selection of Classroom

(Answers to Question 15)

fresh paint
location
matching/appropriate furniture

my own 4 walls
water in classroom
more storage

Heating/ventilation/air conditioning
natural light
sound proofing

Quiet
room and light
storage space

walls to separate from other rooms
air conditioning/heater
noise level-

air conditioning
clean air
proximity to facilities (bathroom, cafeteria)

a door that closes
full size walls
equitable room size

brightness/airflow/lighting
size
available water

A good location, off the street and parking lot
Enough room
ventilation, temperature control (see notes)

In main building
air conditioning that works quietly
close proximity to restrooms

quiet
your are in control of noise level
limited distractions i.e. window

windows for natural ventilation and lighting.
bulletin boards,
access to water

Access to water
a 2nd window for cross ventilation/light
sufficient storage

Size
sink
windows

permanent classroom
located near grade level team
noise

size
water in classroom
storage for supplies

in the building
light
new

Inside school
close to team
close to playground access
4.away from noise

in the building
away from the lunch area
in the same pod as the grade level I'm teaching

quality health standards i.e. no asbestos
safety close proximity to school
sink

size
location in school
storage space

quiet
spacious
close to supplies

quiet environment not near the lunch area
good lighting
good ventilation, air circulation

enough space and storage
inside where the main bldg. Provides water, sinks and center work area
easier computer printer access and classrooms are better maintained

size
storage boards and white boards/bulletin boards, 4
cleanliness

How large is the room
Is it clean and safe
Does it have communication to 911 or office staff

Proximity to MPR for music activities I do
ventilation - airflow (catches prevailing breeze
size and brightness (windows and skylights

larger in size
keep playground noise to minimum
storage

Adequate lighting
ventilation of fresh air into classroom
room size

sink-washing hands -
science, art
white boards to eliminate dust -

safe/noise
size
water

phone
air conditioned
sink

size
air
storage

close to office
full view of street for safety during weekends
near bathrooms

size,
location
who neighbor teachers are

Working air conditioner
Big room
water

size
location
quality of ac

more, much more room. My current room has no room, it is a misnomer
cupboards that opened more than a 30 degree acute angle
built-in shelves attached to freestanding walls

location
has windows
size

size
storage
noise level

size
location, proximity to same grade teachers, playground, office
shape

square footage (storage, too)
quiet
access to water, elect. Etc. no water in my portable

quiet surroundings
windows, yet not looking out onto playground
sink with water

location
size
noise level

permanent classroom-completely enclosed
permanent classroom with minimal noise from neighbors
portable with adequate ventilation

Quietness
space
near bathroom

light-windows
sink
noise level quiet

size
cupboards for storage
location

size
noise level
window

Large room(space for desks, floor space & small group space
single desks (not large tables or trapezoids
sink and storage area

quiet
sink
larger size

cabinets
sink
room size

4 closed walls
large
windows

Balanced - behavior
academic abilities and
study skills - -

quiet (solid walls
sink
built-in shelves

light-natural
outside door
size/space

outside door
sink
built in cupboards

student friendly
ample room
location

large
quiet
good a/c

size
window
outdoor passage

self contained
adequate space -

self contained classroom /4 walls doors and quiet
an air conditioner that works
larger room to allow for centers

space, present size
windows tinted
storage space closed off by moving white boards

open windows, light
quiet, insulation from other rooms
nearby work room/office

with grade level
windows
access to bathrooms

Windows that open (big windows)
good storage space
carpet

space-lighting
storage
clean carpeting and freshly painted room

size(permanent room with sink)
location(away from playground noise)
windows and natural lighting

away from playground noise
size
near grade level

space (usable)
freshness (clean painted)
location(proximity to playground, office

location
size
age

size
cleanliness
location(near office, restrooms

Size, room to move & do centers
location
water, storage

Large enough for desks and room for center grouping
sink
ample cabinets and drawers for books and supplies

Lots of natural light, windows, skylights
space for kids & materials
grade levels clustered together

windows
source of water
view

close to other teachers at my grade level
close to office/work room
noise level

windows
phone
water

space
light
noise location

next to other second grades
facing courtyard
close to office

location - away from playgrounds and lunch tables
exterior view- students need to work outside at times
-

Enclosed room
room to move around/nice big space
sound proof

location near someone I can team
quiet location - grass, trees, etc
full size-running water

size
air and water
storage

air conditioning and heating system that works
windows-

available water
outside door/window
space

windows
sink
space

outside access
space
sink area

windows
door to outside
air conditioning

location
size
facilities (sink, etc)

size
noise level
close access to library, computer room, etc

air conditioning
light
spaciousness

size- and storage
location in respect to playground bathrooms
location in regards to other grade level classes for learning

climate control
access to a bathroom
water in room

location to playground
restrooms
office

single desks to lend for flexibility
carpet for sound
tackable wall space

natural light - windows
openness- size
lots of useable/tackable walls

quiet
windows/light(natural)
size

windows
built in cupboard space
sink/space for students to walk around

windows
sinks
space lots of it

Windows, natural light and a view
self-contained and not in the traffic pattern so we're not interrupted frequently
adequate air conditioning and heating

away from recess area
close enough to workroom, office, library
size though all are the same

Little outside noise, I am next to preschool special ed play yard
fresh air
room to move freely and for storage

quiet area
close to team teacher
black top and ramp area not in field

size
proximity to front of school
no paneled walls

Black/wipe boards
sink
storage

close to teammates
away from playground
privacy

enclosed (4 walls
close to office or work areas
away from playground

controlled air circulation
windows and door access
physical space

closed in classroom
newer facility
location relative to team teachers

size
doors
location to office

self contained, no open walls
roominess
fully equipped, water, phones, etc

closed classroom
air conditioner that doesn't leave dirt throughout room

wall that can be stapled into

closed - self-contained
lots of bulletin boards and magnetic white boards
control of heat/air

size
location -

ability to isolate class and students from surrounding noises and other students and other instructions
to control temperature and air flow
proximity to team mates of same grade,
if any choice was available more modern facilities including storage and water /sink

size
lighting
storage

quiet
accessible
well ventilated

Enough space for children & furniture (not crammed together)
cupboard space, built in drawers, sink in room, counters
windows

noise (exterior)
temperature
lighting

two exits
running water
windows that open

size
storage
lighting

size
location away from outside noise, i.e. freeway, lunch area
storage space

space of students, desks, materials
storage
easy access to playground

space floor space wall space
physical environment ventilation, lighting etc
location, restrooms, drinking fountains

corner room with minimal 'traffic' flow
storage space and inside sink
white board space

windows
storage/cupboards
size/bright/clean/well ventilated

size
natural light
self-contained

away from playground
near bathroom
near office

lots of space
lots of bulletin boards
lots of storage room

size fits 30
windows to the outside
self-contained

space size of classroom and storage space
windows
location

easy accessibility
more built-in bookshelves and counter, cabbies
larger wet area

space for children
sink area
storage space

not too close to a playground
not too close to an eating area
a room with windows that can be opened
4, better lighting

white boards
storage
space

distance from playground
access to pod -

space
storage
layout

size
technology wiring
sink

clean new facility
appropriate lighting
nice size

windows. my classroom at Moulton had none
space to move around the room
sinks with clean running water

size
ventilation
sinks in classroom

sink,
sunlight
location

size
lighting,
windows

a classroom with much more light
new carpet -

Inside bathroom and sink
art area

enough closet space/cubbies for minimum # of children
water
windows

away from playground noise
have air conditioning
plenty of room

windows that open
built in storage space
thermostat controlled inside temps

space
window/walls
storage

size
location in relation to playground/office
location in relation to others at same grade level

size
storage ac/heat ventilation

windows
running water
built in storage

air conditioning
size
water

space for all students/desks/cupboards
lighting in class
soft walls to hang things

size
running water/sink
condition of classroom

size
light
locations

size
windows
location

student space
storage
location (away from playground etc)

size
wall space
proximity

Lots of space
lots of natural light
adjoins other rooms

windows
space - bigger than a portable
cabinet/storage areas

In the school building
Water
Connected to a pod

storage
windows
sink

location close to same grade level
size
storage space

permanent classroom
quiet location
convenient location

size
location -

size
clustered w/other 5 grades
away from playground distractions

location
space/cabinets
room (sq. footage)

space
light
storage space

physical space
storage
light

Access to natural light (window thick walls so
my students may work noisily at times
cabinet space/technology

3 Pod-
close to office
teaming situation

student work space
materials storage
water

main building
with grade level
work room

storage
location/workroom
windows

Quiet (we have open classrooms
windows to the outside to see out
large enough for desks and centers

space
doors
windows

sink
size
windows

light
compatible teaching style-neighbors
easy accessibility in and out

windows and natural light
good lighting (electrical
ample size

natural light
ventilation
secluded location not central because of foot traffic

portable
room with a window or outside lighting
my own air conditioning controls

enclosed
lots of space
lots of storage space

walls and door
windows
water

centrally located
storage furniture

Built in sink
close to bathroom
close to the "going ons" with the school

Location away from playground noise
inside main building
near team (grade level)

close to bathroom
size
inside the building

large size
good location-close to copiers, etc
clean

close to another room incase I need another teacher to keep an eye on my class or vice versa
work area in central pod and area for storage
proximity to copiers

size
noise factor
location to main services

room size
access to water pod area

size
building vs. portable
location

space per student
technology
environment (sink, water a/c etc

space
windows(light)
wallspace (allowing for displays and bulletins

Interior environment (cleanliness etc)
location (in the school near office, copiers, etc)
storage

size
location
storage

location to office, bathrooms etc
running water
size of room

size
location, front of school, avoid playground
lighting

size
location
storage space

air conditioning
more cupboards
new carpet/paint

large enough
desks in good condition
natural light

location - near grade level
air conditioning
storage

Full size classroom
air conditioning
sink/water in classroom

permanent classroom - large
bulletin board type walls to ceilings
square room (unlike bowling alley I am in

air quality (windows, proper ventilation etc
size not a bowling alley as it is now 2 portables divided into 3
not a portable

size
air conditioning
condition/cleanliness

size
quality - carpet-paint
air from window flow, very important

windows
water in the classroom
size

space available ventilation
room environment/sink, painted walls in good condition etc

good ventilation
quiet location
lighting

Internet/electrical/av wiring
windows-light
size

size
location
condition

large room
windows that open/close
bulletin board space

away from the black top room overlooking courtyard or grass area
carpeting to the door

size
location
storage space

space
location
light

appropriate space for the number of students and furniture that will occupy it.
Adequate storage for student and teacher resources
condition - everything clean and in working order

size for 33 students
heating/ac
sink & water to drink

sink
air conditioner/heater
spare cupboards

sink, access to water
air conditioning
location to playground (far enough to not be bothered by noise, close enough so it is not a 10 min hike

conveniently located
size
a/c and heating

size - larger the better
Location in school "noise factor"
amount of storage and air conditioning

windows - open-ness
light (not dark)
designed - physical lay-out in harmony for centers/teaching

Storage, there needs to be some
water
windows, fresh air

windows
non toxic
air circulation

In the school building closer to restrooms, labs, workrooms
running water for science, art, hygiene
space and storage; less noise

Near teammates
in the bldg. W/water, near office and restroom
not used after school

Location
surrounding noise
appearance

Floor space
outside noise level
storage

Adequate floor space with super storage including book shelves quiet environment away from lunch and recess noise windows providing natural light

Quiet location
bright
storage

Size (30+ fifth graders need lots of room
location (I'm in what we call cell block B)
windows, (I have one small window makes me feel claustrophobic and lack of natural light is depressing

size
being in main building -

location
amount storage space
windows

easy access location to office and spots that will help w/my student council advisor position
quietness
window/door placement and room design

bulletin board space (sufficient)
storage, ample
sink in room, bathroom and work room closer

air conditioning
size
in main building (not portable

proximity to office, restrooms, workrooms, lounge area, running water
proximity to grade level team members
area with maximum sunlight, minimum playground noise

cleanliness
temperature
classroom relationship to office

sink w/water fountain
amount of space, at least 30' x 30'
window or skylight, door to the outside

size
storage
running water

size
location
lay-out

space
windows
storage

size
storage
cleanliness/brightness

windows that open
not near the playground noise
more natural light

Size
Windows for air
clean

be closer to the office
larger classroom
fresh air flow, open window on one side and the door on the other

7.2.2 Permanent v. Portable Classrooms

Answers to Question 16

Preference	Why -
depends	depends on factors in question 19
depends	it depends, if the perm classroom is large and quiet, I prefer perm. If not portable
depends	both have positives, permanent rooms have better equipment and sinks, portables seem more private but are uglier on a campus
no opinion	17 times, no comments
no opinion	as long as it is large enough for centers
no opinion	both have +/- portable + air - no water and more wall space, permanent no air water more windows
no opinion	either is fine, as long as there are walls
no opinion	either is good with above options
no opinion	haven't tried a portable
no opinion	I don't care so long as top 3 choices are met
no opinion	I have had both and can adjust to either
no opinion	I have taught in both, and as long as they are new and nice esp. portables they are great
no opinion	I love portable walls, staple everything up
no opinion	If the portable had running water and was large it wouldn't matter
no opinion	I've done both they are both fine
no opinion	I've never been in a portable
no opinion	I've never taught in a portable classroom so I have nothing to compare
no opinion	I've only taught in portables
no opinion	never taught in permanent but I'd like water
no opinion	permanent have storage and feeling of permanence, portables have air - but old ones have mold
no opinion	permanent have windows, sinks, portables have great walls and flexibility
no opinion	portables are larger, but permanent rooms have water to wash hands, clean paint brushes, etc.
no opinion	pros and cons of both
permanent	17 times, no comments -
permanent	above reasons/ less adhesives, toxic materials used in construction, light natural air
permanent	access to office, library, others at grade level
permanent	access to school facilities 'i.e. library, bathroom, water, office
permanent	access to water, air quality, size, safety quieter, close to necessities
permanent	access to water, especially for younger children
permanent	accessibility, central location to services
permanent	after teaching in a portable for 12 years I feel the ventilation in a portable is unhealthy
permanent	air quality was better and I did not get sinus infections However it is quieter
permanent	air quality, allergy problems minimized, learning enhanced
permanent	at [my school] they are superior more natural light- more cabinet space and access to a work room
permanent	because I have a sink and wonderful storage cupboards
permanent	because they seem to get more perks. 'i.e. new carpet
permanent	better air circulation, although not sure at this site
permanent	cabinets/storage & work room
permanent	centrally located to lib, restrooms, water, office etc
permanent	classrooms have running water (usually) and the floors are solid and make less noise when walking etc.
permanent	cleaner, brighter, doesn't have musty or chemical portable odor
permanent	cleaner, more storage, less mildew
permanent	closer to copy machines and central pod location for easier access to other classes and work area space
permanent	closer to mail building, access to water in room
permanent	closer to office, supplies, library/computer lab and other teachers
permanent	closer to office/bathroom/workroom/multipurpose room etc.
permanent	closer to other rooms and the office
permanent	closer to the office, work room (but there is no fresh air flow
permanent	closer to things I need, bathrooms, office, copiers-also running water in the classroom
permanent	closer to water source, clean hands and room are important to overall health of teachers and students
permanent	easier access to office, workroom etc. water availability, noise, no clumping floors, safety when working on weekends, nights, etc
permanent	feels substantial lets children know they are important and that things are not temporary
permanent	generally have better location
permanent	generally more cupboard space and windows, electrical and plumbing
permanent	has water
permanent	I am concerned about the health issues for myself and my students
permanent	I don't like the potential of mold and the space for re-circulated air. There are many leaks in the two portables I have been in
permanent	I don't mind either on as long as they fit the criteria above

permanent	I feel like a part of the school building
permanent	I feel more connected to the rest of the school, and I like having running water. I feel safer.
permanent	I feel they are safer in the event of an earthquake
permanent	I firmly believe that portables contribute to poor health (colds etc)
permanent	I had bad experiences in my portable, allergies, also, I do not like the storage or too rectangular configuration
permanent	I have a drain under my portable, I have allergies to mold and mildew
permanent	I have had so many bad experiences with the air quality in portables I bought myself an air filter this year and I have had parents come to me and say their children's health has improved
permanent	I haven't had opportunity because of storage
permanent	I just like having a sink, If portables had sinks I really wouldn't mind teaching in one
permanent	I like being a part of the main bldg.
permanent	I like the built in storage
permanent	I like the logistics and ability to team with others in a permanent classroom, but I also like the portables because they are more self contained. I can be noisy and quiet when I choose
permanent	I like to keep things clean and orderly, much easier to do w/storage and water
permanent	I prefer being close tot he center of the school and portables are usually located out on the playground
permanent	I prefer closed classrooms
permanent	I teach K with 30 kids and I need a bathroom in my room
permanent	If I can open the windows and doors, [at three schools] there is nothing that opens
permanent	If I could have a permanent classroom with doors I would prefer that
permanent	I'm a male teacher. I like working in open portables because of misunderstandings that could happen
permanent	it has more windows, its larger, and it has a sink in the room
permanent	it has sinks
permanent	it is closer to facilities(office, copiers, restroom) and it is larger than portables
permanent	I've been in both and they both have positive and negative qualities. It; up to the teacher to make the environment workable
permanent	larger
permanent	larger
permanent	larger, has windows, more storage space
permanent	larger, more storage space
permanent	larger, sink available
permanent	less echo sounding/better continuous ventilation and air flow (heat or cool
permanent	less mildew
permanent	less noise, more room, smell portables at our school have a bad smell
permanent	less noise, more built-in storage, sinks, safer in an earthquake, close to center of school
permanent	less odor more ventilation
permanent	less sterile looking more in the school mainstream
permanent	lots of cupboard space not matter what
permanent	more built-in storage sink more charm
permanent	more closets etc
permanent	more convenient, running water, centrally located , more attractive, more quiet
permanent	more light, wall space, open feeling of it
permanent	more solid, don't leak, don't smell like artificial-allergenic materials, larger plus cabinets and plumbing
permanent	more space sink and drinking fountain, students need to be able to wash their hands without running to the restroom at all times
permanent	more storage and windows
permanent	more storage, but like portables because they are closed.
permanent	more windows, better view larger. Also there have been complaints about allergy problems in portables from teachers and students
permanent	more windows, lighter
permanent	more windows, sink, more storage, wiring
permanent	newer portables are fine, but some older ones leak and have musty odors
permanent	no mildew, better HVAC, noise from walking on portable floor is annoying
permanent	noise and ventilation
permanent	noise level lower, more storage, sink in classroom, bulletin boards, nicer atmosphere
permanent	obvious
permanent	part of the building
permanent	permanent classrooms provide a sturdier, quieter more spacious environment - better insulated, no noisy ramps or noise from neighboring portables, also the long hallway environment does not make efficient use of space and deal with real classroom needs.
permanent	permanent for a sink, no mold or fungus that portables get, new portable great for hanging student work
permanent	portable - we only received Sparkletts recently - no sink - little coverage during rainy day, far from restroom
permanent	portable classrooms tend to give students with allergies more problems. Many do not have running water or appropriate storage.
permanent	portable is far away from main facilities, no attached workroom, noises echo and air conditioning make it difficult to hear, some are too small, not enough cabinets
permanent	portable lack storage, water, adequate natural light, often have stronger odors from industrial glues, easier to break into, located on perimeter of the school
permanent	portable smell musty no sink & the floor makes too much noise when kids move around
permanent	portables are poorly constructed, floor and ramp noisy, no storage, no sinks (water

permanent	portables are too far away from facilities
permanent	portables don't provide running water, they're far away for emergencies, restrooms, copy machines, no storage for supplies compared to building with pods
permanent	portables stink
permanent	portables tend to take on a musty smell, have few windows, they're cramped; no sinks
permanent	possible built in cabinets/solid foundation
permanent	provides a greater sense of stability and has tech and sink/water
permanent	quiet
permanent	quieter
permanent	quieter, usually larger, access to center workroom
permanent	ramps are too noisy for portables not enough windows
permanent	reasons in question 19
permanent	right now I'm in 1/3 of a portable and it is very crowded. However, it looks like next year, I'll be in a larger permanent classroom
permanent	roomier and aesthetically more appealing
permanent	running water, students aren't drenched on rainy days, better accessibility to other teachers
permanent	safer for 1st graders to be in the building, sink in classrooms close to bathrooms, two times larger than my portable, available storage, cleaner air, printers nearby, more stable in an earthquake
permanent	seems safer, less allergy troubles
permanent	sink - water
permanent	sink and built in cabinets and drawers
permanent	sink and storage
permanent	sink, closer to supplies, closer to bathroom, closer to peers
permanent	sink/accessible to water for cleanup
permanent	size is larger and more natural light
permanent	size of room availability of a sink/water, and built in cabinets for storage of classroom materials, location to office
permanent	size, accessibility, central location to services
permanent	size, smell , water
permanent	size, storage space, ventilation
permanent	size, ventilation
permanent	smell, dampness
permanent	solid, less noisy
permanent	sometimes portables have an unpleasant odor
permanent	space, availability of sink and fountain in class, storage, proximity to colleagues
permanent	space, not portables because of space, noise and air quality
permanent	space, sink, storage
permanent	storage and access to main bldg.
permanent	storage behind boards, sink area, wall of windows
permanent	storage, magnetic whiteboards, soundproof(floors, walls etc.
permanent	storage, sinks
permanent	storage, space, proximity to office
permanent	storage/building access- bathroom, teacher's lounge/pod access/cleaner and nicer rooms- our portables are dirty and ugly dust causes allergies
permanent	the classroom should have running water, space in which to move for collaborative groups and fresh air or air conditioning we have no drinking fountain or sink
permanent	the issues listed above
permanent	The older portables have a distinct odor, are rarely cleaned, carpets are dirty and swept about once per week, no indoor water, no center work area, no small group area for parent helpers
permanent	The permanent classrooms have better build-in cabinets, pods, for working space and proximity to office, restrooms, running water/sinks and team members. Also the permanent classrooms have better computers/ printer equipment.
permanent	the portables now are not a full size portables long rectangular in shape that do not allow for flexible movement
permanent	the room is brighter, storage space and cleaner
permanent	there is usually a lot more storage space and it is more secure, inside or attached to a building
permanent	they are larger and they have sinks w/air. Storage is much better
permanent	they are usually on the central part of the campus
permanent	they usually have two exits and running water as well as larger size
permanent	They're larger, have more storage and are usually closer to teacher workroom and restrooms
permanent	usually the size and shape of permanent, at least at the schools I've been
permanent	view
permanent	want a sink-water-windows that open (lots of windows)
permanent	water availability, proximity to office
permanent	less distractions, usually have a sink, closer to main school, not as dirty
permanent	water
permanent	water and phone available in the classroom
permanent	water supply, safety and health issues(portables have too many formaldehyde fumes and molds
permanent	water, built in storage
permanent	water, closeness to necessities for young children

permanent	water, hallways cover
permanent	water, sink - part of community
permanent	you have more contact with other colleagues

portable	3 times, no comments
portable	air conditioning, control of my thermostat
portable	at my school the permanent classrooms have very small or no windows, none of which can be opened. The doors open up to a central atrium where students eat lunch and it is very noisy. Also I like having my own thermostat to control climate not central air.
portable	At this school site only portable classrooms can be closed off from other classrooms and noises, however as a teacher you sacrifice necessary items, 1, use of sinks and water for projects hygiene and fluids that are much needed. Releasing or waiting for 30 students (sometimes 90 students after PE periods to get drinks causes huge losses of time. we have only 2 drinking fountains for all students outside. Our temperatures are usually warm and students require water to drink. 2. Use of built in storage so room is cluttered and creates a maze. 3 proximity to main office, student and teacher bathroom facilities, work space areas and telephones. All of these are a problem and eat away at precious time for both students and teachers. On a more positive side, cold temperatures esp. air conditioning are very uncomfortable for my body. I like being able to adjust the a/c. heat and air ventilation. The down side of this is the a/c. unit makes lots of noise and makes hearing students and teacher more difficult so you have to raise voice, ask for repeats or be very stuffy and uncomfortable during oral reading or discussions, reports etc.
portable	because at our school the walls are not permanent
portable	because climate can be controlled by teacher
portable	because it is enclosed and quiet, otherwise I would prefer a permanent classroom where rooms are not open
portable	because o the noise situation in the building, this used to be an open school. Now thin portable walls separate the rooms
portable	because of the noise factor in building
portable	because quiet, self contained
portable	because the portable classrooms are usually larger
portable	bigger
portable	bulletin boards
portable	depends on set up of school, open school environment
portable	due to 20-1 the inside classrooms were reduced in size substantially
portable	has air conditioning
portable	I know who's making the noise, My class, not my neighboring teacher's. Also I can control the temperature
portable	I like being control of my own noise instead of an open area
portable	in this school permanent rooms have some open walls
portable	Its much larger than the permanent classroom
portable	larger, less distractions
portable	lends for flexibility (walls are often not sound proof in a permanent building - some are simply sight barriers
portable	more room for reading groups and older kids upper grade
portable	more space
portable	more space for 32 students
portable	much quieter, more room to move around especially [my school]. When I taught at O[my previous school] I liked the permanent rooms
portable	my portable is in better condition than the permanent classrooms at my school. I have air conditioning and bulletin board walls
portable	noise doesn't drift between rooms
portable	only because our portables have air conditioning for our year round classes through the end of July
portable	permanent classrooms open into each other, no doors/or privacy
portable	prefer if provided with adequate storage, they are larger and generally brighter than permanent rooms
portable	quieter room environment than the open classroom building
portable	the classrooms inside the building are open-space classrooms
portable	the rest of [my school] is an open school and it can be very noisy
portable	The state portables are the largest on campus, The small ones are ridiculous for anyone to teach in

7.2.3 Additional Comments

Answers to Question 18 (a.k.a. Voices from the trenches)

I use an overhead projector everyday, I wish my ac was quieter

Does mold and other bacteria grow under portables? Air conditioner, which is necessary, is too noisy.

Noise is a huge problem, it sometimes seems louder in adjoining classrooms than in the room creating the noise. My classroom is in a pod adjoining 3 other open classes

We need walls & doors to function. Permanent classrooms are so poorly designed, noisy, with inability to turn off lights since they are also used by other classrooms.

My portable is right next to the playground. I can not open my door for fresh air between 9-12:45 then the afternoon PE begins. The blower on the AC is very loud making it hard to teach over. My window and door are on the same side so I get no cross ventilation

The best schools I've seen were old ones - with banks of windows to open (on both sides of the room, for cross ventilation) and a sink with water. I know [my school] won architectural awards but its not a good building for a school. Note: 19 - Windows so we're not closed in

As long as the school as an open environment allowing noise to travel to other classrooms I vote for a portable. I believe I do a better teaching job

Note question 18, reduced class sizes in lower grades forced upper grades with higher class sizes into portables question 21, I tried using portable fans because they were quieter but they were not able to move the air around enough. Comments, I have read that natural lighting has made a significant difference in student achievement as well as starting times.

My air conditioning unit is very loud it interferes with teaching, also we face a busy street - street noise

Darken room only when we're watching an educational video (not every day but every time we watch a video.

I can only open the windows in the back of the portables. If I open the front windows it is too noisy. I face the playground and recess occurs all day long (each grade level is on a different recess schedule) The noise was problematic during testing from recess. curtains would be a good idea for the portables facing the playground like mine. The students get distracted with watching other students playing

Please do not give this to teachers and expect to get it back immediately. A little professional courtesy (especially at the end of the year) would be appreciated.

I close the skylight to darken the room when watching a video.

Having internet access is wonderful, but printing to printer in the bldg. Is very inconvenient. It is also very difficult not having water in the classroom.

Mold in portables under ground problem for allergies. Portables need 2 exit doors. Please help Calif. Get more square footage per child. It's crazy. Especially with computers taking more space. No phones in our portables, no link to office, no water.

Carpeting is not cleaned enough or rather not replaced often enough! It is disgusting Give me linoleum floors with an area rug any day.

My room is either too hot or too cold. Air circulation and proper temperature almost a impossible feat to obtain

Tremendous construction has been going on for the last two years, really bad during STAR testing this year. Jack hammer one day and ground pounder and earth movers

Lights will be out when I use the overhead projector

I have no door, I must leave through another teacher's classroom, I have no access tot he lights. We are a middle room. The circuits are in the outside rooms, it is unsafe residing in the middle room. We have enough land to build permanent wings on our school site. Please help us to improve instruction by increasing classroom size.

I have no secondary window to use for cross ventilation and the air conditioning unit has to be shut off for students to hear instruction. They tried to adjust it but it is still too loud. If I had a second window, I probably wouldn't need to use it at all which would save a lot of money and energy

I would love to be able to close off some of the noise around me

Our school is open space so its impossible to control the noise level around us.

Several of the lights that are controlled by the switch in my classroom are located in the classroom next door. I feel it is important to have a quiet working environment. Although we have an 'open' school environment, it would be helpful to install walls and doors between the classrooms

I do not have any control of my lights in fact sometimes partial lights are turned off because of other classrooms. As of this month May my air conditioner has begun to work and has been broken since Sept. I would love to have a door and complete walls so sounds couldn't come in my class, which hinders learning when children can't hear.

Storage space in my school and room could easily be converted as described above. I have asked for a Formica countertop to replace the hardboard top for the past eight years with no success. Why were the same type drapes used for replacement when they have been very unsatisfactory all these years. Why not tinting or shatter proof windows (tinted) used for replacement

Orientation is important my room's wing runs NE to SW/ very little direct sun enters. Porch covers help

I use the overhead projector often with the lights off

Our heating systems it either is on full blast or it's off. It can't be adjusted. Rooms are very dirty, not cleaned until the end of year or I clean it all the time myself

I don't adjust the thermostat but I do turn on the heater in the morning to warm up the room. I close the door when children walk by who are coming back from upper grade recess

Very unhandy to close curtains- portable fan is mine, very hot in Sept/Oct. no air cond. Window provide no ventilation

I do like our cathedral ceiling and whiteboards, The drapes are horrible. They are almost impossible to close so we do without closing them sometimes even when darkness is desired. Irony; drapes were just replaced with the same difficult set. Vertical blinds would be nice. Fan blows papers around. Heater is extremely noisy.

Question 21 teacher also answered N/A to last 7 responses with memo: I share a large room with a wall that was built to divide it in half, we share lights, thermostat, etc.

In a shared classroom with a drywall separating the two our lights were the same, so we could not turn them off during teaching time. We also shared a phone and a sink

Note question 18, we did a drawing out of a hat, we agreed on that.

Lights work on 1 switch I turn them off for the overhead, computers, and TV screens. Note question 19, unnumbered answers, storage, bulletin boards

The classroom has an electrical problem and at times throughout the year a group of lights has been out

My classroom is about 18' wide and 30' long. Way too narrow to adequately teach 7-8 yr. Olds.

All classrooms should have windows that open. This school doesn't and kids (myself included) are always suffering congestion, headaches, sneezing. Our school is old and is in desperate need of the vents replaced and proper a/c. It's hard to learn when you're sneezing all day and suffering from headaches

Fresh air and ventilation are very important in keeping students alert and the classroom light and airy for maximum learning

This is an old school, the black soot coming out of the vents is frightening. Since we were built on an open structure basis, and then changed to open the a/c ventilation system is very substandard. I'm quite sure it contributes to germ infestation.

The best thing about my portable is the control over the heat and air conditioning. The permanent bldg. Doesn't have individual control. It's always a problem

I have no windows in my room and I must walk through another class to get to an outside door, I have no light switch, it is in another classroom

I have been in several rooms in different districts and feel that windows or lack of in my classroom has had a major impact on my teaching and the students learning

I consider the physical environment to be an extremely important factor in student parent and teacher attitudes and feeling about school

I'd love to open windows but noise is always a problem. The lights in the classroom seem insufficient, but we get use to them. The light is grayish.

I do not have blinds to block out light

If the permanent classroom had a door access to the adjoining classrooms, I would find this more ideal. I enjoy the open environment, but find it inconvenient when it comes to testing situations and quiet time

I have an open classroom in a pod situation. While it is conducive to team building and support from fellow teachers, it is noisier and distracting to my students, I would prefer doors

I think children perform better in a closed classroom with few interruptions

Temp. control is a major problem in my room which is colder than the others on my system. Noise level is high from male teacher next door (panels separate rooms) whose voice booms

My windows won't open properly or I would open them regularly, My classroom has poor lighting. As a wearer of glasses this provides difficulty for me. I feel eye strain on overcast days. I also receive weekly complaints from students regarding poor lighting. I truly feel that this problem at [my school] has been made known yet nothing has been done about it.

Permanent classrooms tend to be bigger, The children need space to move around. I love my classroom and would not be happy in a portable.

Many portable classrooms are in need of repair or replacement, especially on older campus grounds

Although we have been told that our windows have been tinted for sun glare this proves to be ineffective. Teachers still have to construct devices that cover the windows to reduce glare and darken the room

Did CUSD hire you to do this survey?

I have also taught in an open classroom where students can hear and see what's going on in all classrooms. This is the most ill conceived structure for learning, note question 21 windows don't open

You can't give me a survey and expect that I drop everything I do so can fill it out and return it to the office the same day. Please respect my teaching responsibilities next time

I think upper graders should get priority on the bigger classrooms, It doesn't make sense that a class of 20 smaller students has a bigger room than a class of 29 bigger students

I currently enjoy my classroom very much. It is what I consider large: have sinks, air conditioning and storage. I am not against portables but against not been given a full size portable. I believe it is good for myself and students to breathe in some fresh air, helps us all think

I like a lot of white board room in front, back, and the sides

Because kindergarten is considered 20-1 but it's not considering we still have 34 bodies to accommodate I doubt the extra fixtures (, closet for back packs) will ever be addressed

Can improvement be made on the upkeep of our buildings? The floors that bounce when there's movement in our room or next door, record players skip and overhead projection jumps on the screen

We'd like more space! Tiny portables for tiny people don't offer room for the extra movement that happens ALL DAY

Teaching pre-school without running water makes me feel like it's the 1900s. We carry pails of water! Also we share inadequate bathroom facilities with the rest of the school, The floor is often wet and slippery

20-1 is great, but when classroom size is so greatly reduced stress is increased noise increased no room for centers

My class is part of a large classroom, I have no access to thermostat, intercoms are shared

Teachers need lots of storage space

I love my room but I would like to have more light (natural)

I loved my previous room because it had a large skylight with adjustable blinds. I wish my current room had more windows instead of narrow slits

I would love to have a window and door. If they put a door up we wouldn't get ventilation

After teaching [at my school] for five years I have come to really appreciate the effects of natural light and closed classrooms. The only thing I would change about my classroom is not having a glass slider between my room and room #15 and having direct access to the work room. With 30+ 4th graders it would also be nice to have extra square footage.

I turn off ac before propping door open, I miss having windows to open, I try hard to conserve energy by not using all lights all time

Our rooms are open, without windows, it can be distracting due to noise of other classes

I helped open the school, and we had choice of classroom since then I feel that being in a room gives me priority for it, unless I change grade levels. Teach w/all lights out only when doing projects requiring it(science) or when using an overhead. Wind and noise keep me from opening my door more often. Adjusting my thermostat doesn't do much good.

My classroom has very poor air circulation due to construction of walls to form additional classes. No windows open, open door is too noisy

I was happy with my location and still am

Lights in my room are also controlled by other rooms I can't turn off all the lights for a movie because it would effect surrounding classrooms

Wish I could open a window, very noisy only crack back window. Open door for ventilation except at others recess and lunch noise

The portable I am in is way too small for 21 bodies. The size absolutely affects learning in my classroom. It makes an already challenging job that much more difficult. Small rooms like mine are not shaped or equipped (heard of painting/cleaning/washing hands without water for 20 six year olds) for children this age. These tiny rooms are far from the best interest for a learning environment for young children.

I have a great room. We always keep our doors shut to keep it cool inside and it is noisy in the lunch area right outside our door, We darken the room to watch movies. As a ritual I turn out some lights when I read to the class.

The light provided by the skylight make teaching with an overhead projector excellent

A room with theatre-like wall for projection would be great if we had projection devices

My thermostat runs on extremes - My class gets way hot/stuffy or chilly w/quite a breeze depending on fluctuation between 1 or 2 degrees (i.e. 71 hot 70 cold

No window to open, Superintendent's instructions do not allow for open doors in air-conditioned rooms, I can and do close the louvers in the sky light at times

The so-called double wide portables are too small! I am in the middle room and the students do not have enough space to move around. Most large projects are eliminated because of lack of space and no access to water. The room is so small that we use the ramp outside to set up centers. The door is always open because the poor circulation in the room gets us sick, since we have no water to wash our hands after sneezing and coughing all over them, we get sick more often and pass colds, flu etc to each other because of our close proximity

Have custodian adjust heat/cool up or down. Sometimes lights off when I do a read aloud

My room is bright/clean/with air conditioning. If it were larger, it would be a perfect learning environment, P.S. I have a great view.

Magnet white boards portable classrooms don't have them

Note from section a question 6- not here anymore, it was a portable which was put on our campus in Nov. and removed during the summer. Before that I was in a very old portable that ended up being re-roofed, carpeted etc. I got very sick in that old portable. Our classroom portable numbers change yearly, depending on how many portables we have ---question 22 comments I'm so glad you are looking at this. I'd love to help you more. I've been at 5 schools in my district in the past 21 years feel free to contact me again

I hate my classroom this year! I am in a portable without a sink, removed from campus, and it takes us 10 min each way to the playground. To make matters worse I am next door to adult special ed (they make a lot of noise) and next to a school that is operating out of a church (noise) Plus we face a busy street with construction going on all year. The noise and constant traffic drives me crazy. Oops almost forgot to mention the room is infested with mice. Although traps have been set, the mice no longer enter them, and because of the children, poison cannot be put out.

Student performance on tests is primarily based on 3 factors, educational level of parent, student work habits and the test itself and correlation to curriculum

I realize that 20-1 has created the need for portables, but they're highly inconvenient for both students and teachers. Could teachers and grade levels rotate in the building

AC comes on freezing - nice to be able to control ac but noisy and can hear recess if windows open we are treated as if not as important as those inside the main bldg. No restroom, no workroom. 98-99 we had to fight to get white boards that erased. (additional comments from this teacher, question 19- My primary concern is having 40 kids in the room for a rainy day lunch w/1/2 noon supervisor. Also, no soap we would like Purell or wetwipes supplied for us. Question 20, have to push in TV up the ramp many of us share this TV. question 21-97-98 I was housed in the YMCA rm. I could not use the room after school and was treated very rudely. The Y presently uses our picnic tables and leaves much garbage daily

I'm really a long distance from bathrooms and the teacher's workroom It's frustrating to be crowded

Portable ventilation is poor, either it is freezing or stuffy. Students are encouraged to dress in layers for this situation. Proximity to restrooms and team members truly increases our ability to effective and efficient. Also we are concerned with hygiene due to lack of running water and sinks. Teachers are purchasing Purell or wetwipes with own money for students. Thank you for looking at this very important issue.

Door opens to lunch tables, we have 4 different lunch times and the noise makes it impossible to leave the door open, I have a skylight and keep it open (automatic shutters) all the time for the natural sunlight. A plus for portables is that the door and windows open up to the outside, natural light & fresh air, I work inside the building

I would add a window particularly with a view, to my choices in #19, I have a few slits for windows I find better than nothing. I would hate to teach inside a building with no natural light

Please do not disregard the cleaning, dust, mold, etc of the rooms. Also, portables need to have running water and sinks for drainage

I love my room, just not the location

7.3 Bias Analysis Models

New Model Capistrano, Teacher Bias Analysis - 28-2 (Original population)	Reading Daylight			Change new-old R^2	Old Model Capistrano, Original Analysis C17-rd	Reading Daylight		
Model R^2	**0.248**			**0.002**	**Model R^2**	**0.246**		
	B	Std. Error	p (Signif)	**B**		B	Std. Error	p (Signif)
(Constant)	3.009	0.303	0.000		(Constant)	3.025	0.298	0.000
Classroom characteristics					Classroom characteristics			
Daylight code	**0.475**	**0.086**	**0.000**	**0.011**	**Daylight code**	**0.464**	**0.085**	**0.000**
Operable windows	0.650	0.212	0.002	0.007	Operable windows	0.643	0.212	0.002
Teacher Characteristics								
Teacher 3	-0.917	0.288	0.001					
Teacher 5	-1.335	0.388	0.001					
Log yrs teaching	0.221	0.090	0.014					
Student characteristics					Student characteristics			
Grade 2	10.823	0.251	0.000	-0.037	Grade 2	10.860	0.251	0.000
Grade 3	4.368	0.255	0.000	0.069	Grade 3	4.298	0.254	0.000
Grade 4	0.944	0.252	0.000	0.008	Grade 4	0.937	0.252	0.000
GATE program	-1.432	0.257	0.000	0.020	GATE program	-1.452	0.257	0.000
LANG program	0.827	0.239	0.001	-0.011	LANG program	0.838	0.239	0.000
School sites					School sites			
Sch 61	2.173	0.371	0.000	-0.022	SCH 61	2.195	0.370	0.000
Sch 62	1.634	0.485	0.001	0.049	SCH 62	1.584	0.477	0.001
Sch 64	2.536	0.638	0.000	0.019	SCH 64	2.517	0.638	0.000
Sch 67	1.296	0.418	0.002	-0.062	SCH 67	1.359	0.416	0.001
Sch 72	-1.486	0.378	0.000	-0.027	SCH 72	-1.460	0.376	0.000
Sch 77	0.826	0.429	0.054	-0.036	SCH 77	0.863	0.428	0.044
Sch 81	0.822	0.433	0.058	-0.168	SCH 81	0.990	0.431	0.022
Sch 82	1.664	0.450	0.000	-0.004	SCH 82	1.668	0.449	0.000
Sch 85	-1.316	0.389	0.001	-0.062	SCH 85	-1.254	0.388	0.001
Sch 73	1.574	0.515	0.002	0.047	SCH 73	1.528	0.516	0.003
Outliers					Outliers			
O 82	39.693	7.910	0.000	0.043	O 82	39.650	7.916	0.000
O 71	40.741	7.918	0.000	0.061	O 71	40.680	7.925	0.000
O 17	42.271	7.921	0.000	0.923	O 17	41.348	7.922	0.000
O 58	35.509	7.916	0.000	-0.055	O 58	35.564	7.923	0.000
O 50	36.757	7.911	0.000	0.214	O 50	36.543	7.915	0.000
O 28	-37.307	7.921	0.000	0.163	O 28	-37.470	7.926	0.000
Dependent Variable: Reading Delta (sp98-fa97)					Dependent Variable: Reading Delta (sp98-fa97)			

Figure 22 - Capistrano Reading Models, Original Population, with and without Teacher Variables

New Model Capistrano, Teacher Analysis - Math Daylight 28-2 (Original population)				Change new-old R^2	Old Model Capistrano, Original Analysis Math Daylight C17-md			
Model R^2	**0.259**			**0.003**	**Model R^2**	**0.256**		
	B	Std. Error	p (Signif)	**B**		B	Std. Error	p (Signif)
(Constant)	9.045	0.464	0.000		(Constant)	8.026	0.407	0.000
Classroom characteristics					Classroom characteristics			
Daylight code	0.430	0.072	0.000	**-0.075**	Daylight code	0.504	0.067	0.000
Teacher characteristics								
Teacher 3	-0.933	0.248	0.000					
Teacher 5	-0.688	0.335	0.040					
Log yrs teaching	0.373	0.077	0.000					
Student characteristics					Student characteristics			
Grade 2	9.624	0.216	0.000	-0.088	Grade 2	9.711	0.215	0.000
Grade 3	5.949	0.220	0.000	0.018	Grade 3	5.931	0.219	0.000
Grade 4	1.802	0.216	0.000	-0.011	Grade 4	1.813	0.216	0.000
Absences unverified	-0.263	0.123	0.033	0.000	Absences unverified	-0.263	0.123	0.032
Absences unexecused	-0.029	0.014	0.043	-0.003	Absences unexecused	-0.026	0.014	0.069
GATE program	-1.191	0.222	0.000	0.045	GATE program	-1.236	0.223	0.000
Language program	0.488	0.205	0.017	-0.001	Language program	0.490	0.205	0.017
School characteristics					School characteristics			
School Pop-per 500	-0.995	0.000	0.000	-0.483	School Pop-per 500	-0.512	0.000	0.010
School sites					School sites			
SCH 59	-1.356	0.435	0.002	-0.267	SCH 59	-1.089	0.435	0.012
SCH 60	-1.044	0.397	0.009					
SCH 61	0.808	0.321	0.012	-0.091	SCH 61	0.898	0.313	0.004
SCH 62	0.992	0.403	0.014	-0.457	SCH 62	1.448	0.395	0.000
SCH 66	1.172	0.514	0.023					
					SCH 67	0.838	0.355	0.018
					SCH 71	0.803	0.429	0.061
SCH 72	-1.538	0.330	0.000	0.075	SCH 72	-1.613	0.321	0.000
SCH 74	-0.887	0.392	0.024					
SCH 77	0.963	0.366	0.009	-0.204	SCH 77	1.167	0.365	0.001
SCH 81	-0.678	0.356	0.056					
SCH 82	1.046	0.381	0.006	-0.152	SCH 82	1.198	0.379	0.002
Outliers					Outliers			
O 33	34.151	6.827	0.000	0.089	O 33	34.062	6.838	0.000
O 18	35.754	6.820	0.000	0.639	O 18	35.115	6.837	0.000
O 32	61.994	6.824	0.000	-0.461	O 32	62.456	6.835	0.000
O 48	-45.808	6.822	0.000	0.614	O 48	-46.422	6.831	0.000
O 45	-40.193	6.819	0.000	0.117	O 45	-40.310	6.830	0.000
O 02	-33.568	6.828	0.000	0.898	O 02	-34.466	6.830	0.000
Dependent Variable: MATHDELT					Dependent Variable: MATHDELT			

Figure 23 - Capistrano Math Models, Original Population, with and without Teacher Variables

With Teacher Info				Change	No Teacher Info			
Capistrano, Teacher Bias Analysis		Reading Daylight		new-old	Capistrano, Teacher Bias Analysis		Reading Daylight	
TS2 Teacher Survey Population				R^2	TS2 Teacher Survey Population			
Model R^2	**0.243**			**0.004**	**Model R^2**	**0.239**		
	B	Std. Error	p (Signif)	B		B	Std. Error	p (Signif)
(Constant)	3.277	0.520	0.000		(Constant)	3.905	0.500	0.000
Classroom characteristics					Classroom characteristics			
Daylight code	**0.463**	**0.107**	**0.000**	**0.030**	**Daylight code**	**0.434**	**0.107**	**0.000**
Operable windows	-0.599	0.296	0.043	-0.066	Operable windows	-0.533	0.296	0.072
Teacher characteristics								
Teacher 2	1.097	0.282	0.000					
Teacher 6	0.741	0.321	0.021					
Student characteristics					Student characteristics			
Grade 2	10.710	0.395	0.000	0.077	Grade 2	10.634	0.394	0.000
Grade 3	4.083	0.398	0.000	0.160	Grade 3	3.924	0.397	0.000
Grade 4	0.881	0.403	0.029	0.092	Grade 4	0.789	0.400	0.049
GATE program	-1.439	0.396	0.000	-0.006	GATE program	-1.434	0.396	0.000
Ethnic 3	0.816	0.394	0.038	-0.008	Ethnic 3	0.824	0.395	0.037
School characteristics					School characteristics			
Vintage	0.034	0.013	0.006	0.001	Vintage	0.034	0.012	0.007
School site								
Sch 61	2.269	0.606	0.000	-0.088	Sch 61	2.357	0.607	0.000
Sch 72	-2.225	0.656	0.001	0.007	Sch 72	-2.232	0.656	0.001
Sch 74	-1.568	0.634	0.013	-0.189	Sch 74	-1.379	0.634	0.030
Sch 82	1.916	0.796	0.016	-0.173	Sch 82	2.089	0.796	0.009
Sch 84	-1.417	0.826	0.086	-0.202	Sch 84	-1.216	0.823	0.140
Sch 85	-1.212	0.614	0.048	-0.225	Sch 85	-0.987	0.609	0.105
Outliers					Outliers			
O 28	-36.805	8.211	0.000	0.539	O28	-37.344	8.227	0.000
O 69	-32.407	8.217	0.000	0.365	O69	-32.772	8.235	0.000
O 17	41.258	8.222	0.000	0.628	O17	40.630	8.238	0.000

Figure 24 - Capistrano Reading Model, Teacher Survey Population, with and without Teacher Variables

With Teacher Info				Change	No Teacher Info			
Capistrano, Teacher Bias Analysis		Math Daylight		new-old	Capistrano, Teacher Bias Analysis		Math Daylight	
TS2 Teacher Survey Population				R^2	TS2 Teacher Survey Population			
Model R^2	**0.277**			**0.003**	**Model R^2**	**0.274**		
	B	Std. Error	p (Signif)	B		B	Std. Error	p (Signif)
(Constant)	5.115	0.661	0.000		(Constant)	6.302	0.481	0.000
Classroom characteristics								
Daylight code	**0.497**	**0.105**	**0.000**	**-0.048**	**DAY_REV**	**0.544**	**0.104**	**0.000**
OPERWIN	0.801	0.301	0.008	-0.031	OPERWIN	0.831	0.297	0.005
Teacher characteristics								
Teacher 3	-0.625	0.236	0.008					
Teacher 7	0.430	0.256	0.092					
Log yrs teaching	0.464	0.197	0.019					
Student characteristics					Student characteristics			
Grade 2	10.409	0.332	0.000	0.148	Grade 2	10.261	0.328	0.000
Grade 3	6.165	0.343	0.000	0.223	Grade 3	5.941	0.338	0.000
Grade 4	1.942	0.338	0.000	0.041	Grade 4	1.901	0.338	0.000
GATE program	-1.226	0.335	0.000	-0.026	GATE program	-1.200	0.335	0.000
Ethnic 4	4.348	2.617	0.097	0.116	Ethnic 4	4.232	2.620	0.106
Ethnic 2	1.767	1.049	0.092	-0.024	Ethnic 2	1.792	1.051	0.088
School Characteristics					School Characteristics			
Vintage	0.020	0.012	0.084	0.006	Vintage	0.014	0.011	0.222
School sites					School sites			
Sch 59	-1.758	0.727	0.016	0.003	Sch 59	-1.760	0.725	0.015
Sch 60	-1.311	0.569	0.021	-0.152	Sch 60	-1.159	0.564	0.040
Sch 62	1.065	0.566	0.060	-0.241	Sch 62	1.306	0.551	0.018
Sch 67	0.887	0.530	0.095	-0.182	Sch 67	1.069	0.528	0.043
Sch 71	3.948	1.834	0.031	-0.182	Sch 71	4.130	1.830	0.024
Sch 72	-1.496	0.592	0.012	0.558	Sch 72	-2.054	0.575	0.000
Sch 77	1.424	0.684	0.038	0.190	Sch 77	1.235	0.678	0.069
Sch 82	2.577	0.692	0.000	0.146	Sch 82	2.431	0.690	0.000
Sch 83	0.986	0.526	0.061	0.112	Sch 83	0.874	0.525	0.096
Sch 84	-1.622	0.711	0.023	-0.044	Sch 84	-1.578	0.710	0.026
Sch 85	1.100	0.563	0.051	0.498	Sch 85	0.603	0.541	0.265
Sch 173	2.036	0.659	0.002	0.109	Sch 173	1.927	0.657	0.003
Outliers					Outliers			
O 48	-47.476	6.930	0.000	0.637	O 48	-48.114	6.939	0.000
O 32	62.531	6.927	0.000	-0.243	O 32	62.774	6.938	0.000

[a] Dependent Variable: MATHDELT

Figure 25 - Capistrano Math Model, Teacher Survey Population, with and without Teacher Variables

With Teacher Info				Change	No Teacher Info			
Capistrano Teacher Bias Analysis		Reading Daylight		new-old	Capistrano, Original Analysis		Reading Daylight	
27-4 (expanded population)				R^2	27-4 (expanded population)			
Model R^2	**0.240**			**-0.006**	**Model R^2**	**0.246**		
	B	Std. Error	p (Signif)			B	Std. Error	p (Signif)
(Constant)	3.083	0.320	0.000		(Constant)	3.161	0.319	0.000
Classroom characteristics					Classroom characteristics			
Daylight code	**0.418**	**0.077**	**0.000**	**0.002**	**Daylight code**	0.416	0.076	**0.000**
Teachers characteristics								
Teacher 1	-1.649	0.551	0.003					
Teacher 3	-1.321	0.595	0.026					
Teacher 2	1.210	0.344	0.000					
Teacher 6	0.842	0.306	0.006					
Log yrs teaching	0.398	0.208	0.056					
Student characteristics					Student characteristics			
Grade 2	10.574	0.238	0.000	0.085	Grade 2	10.489	0.236	0.000
Grade 3	4.372	0.241	0.000	0.119	Grade 3	4.253	0.240	0.000
Grade 4	0.953	0.237	0.000	0.060	Grade 4	0.893	0.236	0.000
Gender	-0.298	0.165	0.070	0.010	Gender	-0.308	0.165	0.062
Ethnic 6	1.323	0.754	0.079		Ethnic 6	1.353	0.755	0.073
GATE program	-1.539	0.242	0.000	-0.018	GATE program	-1.521	0.242	0.000
Lang program	0.703	0.252	0.005	0.005	Lang program	0.698	0.252	0.006
Econ 3	-3.060	0.996	0.002		Econ 3	-2.798	0.990	0.005
Building characteristics								
Vintage	0.048	0.010	0.000		Vintage	0.049	0.010	0.000
School site					School site			
SCH 61	2.328	0.461	0.000	0.007	SCH 61	2.321	0.460	0.000
SCH 62	1.229	0.470	0.009	-0.012	SCH 62	1.242	0.463	0.007
SCH 64	3.086	0.916	0.001	0.345	SCH 64	2.742	0.904	0.002
SCH 67	1.068	0.424	0.012	0.016	SCH 67	1.051	0.420	0.012
SCH 70	1.803	0.893	0.043		SCH70	1.615	0.883	0.067
SCH 71	0.990	0.493	0.045		SCH71	0.968	0.490	0.048
SCH 72	-1.089	0.387	0.005	0.078	SCH 72	-1.167	0.386	0.002
SCH 77	0.908	0.412	0.028	-0.083	SCH 77	0.991	0.412	0.016
SCH 79	1.030	0.531	0.052		SCH 79	0.921	0.529	0.082
SCH 81	2.202	0.475	0.000	0.124	SCH 81	2.078	0.464	0.000
SCH 82	2.370	0.481	0.000	0.044	SCH 82	2.325	0.480	0.000
SCH 93	1.388	0.491	0.005	0.051	SCH 93	1.337	0.491	0.006
Outliers					Outliers			
O 82	38.594	7.884	0.000	0.078	O 82	38.517	7.892	0.000
O 71	41.114	7.882	0.000	0.080	O 71	41.034	7.891	0.000
O 17	42.753	7.885	0.000	0.913	O 17	41.841	7.890	0.000
O 28	-37.450	7.886	0.000	0.033	O 28	-37.483	7.892	0.000
O 80	-36.638	7.877	0.000		O 58	-36.746	7.886	0.000
O 69	-32.099	7.884	0.000		O 50	-32.825	7.889	0.000
Dependent Variable: READDELT					Dependent Variable: Reading Delta (sp98-fa97)			

Figure 26 - Capistrano Reading Model, Expanded Population, with and without Teacher Variables

With Teacher Info				Change	No Teacher Info			
Capistrano Teacher Bias Analysis	Math Daylight			new-old	Capistrano, Original Analysis	Math Daylight		
27-4 (expanded polulation)				R^2	27-4 (expanded population)			
Model R^2	**0.252**			**0.002**	**Model R^2**	**0.250**		
	B	Std. Error	p (Signif)			B	Std. Error	p (Signif)
(Constant)	7.505	0.291	0.000		(Constant)	7.558	0.291	0.000
Classroom characteristics					Classroom characteristics			
Daylight code	**0.301**	**0.066**	**0.000**	**-0.051**	**Daylight code**	**0.351**	**0.064**	**0.000**
Teacher characteristics					Teacher characteristics			
Teacher 3	-0.834	0.244	0.001					
Teacher 6	-0.846	0.357	0.018					
Log yrs teaching	0.389	0.076	0.000					
Student characteristics					Student characteristics			
Grade 2	9.442	0.205	0.000	-0.053	Grade 2	9.495	0.205	0.000
Grade 3	5.806	0.209	0.000	0.022	Grade 3	5.784	0.209	0.000
Grade 4	1.754	0.206	0.000	-0.007	Grade 4	1.761	0.206	0.000
Abscences unverified	-0.162	0.131	0.216	0.009	Abscences unverified	-0.172	0.131	0.191
Abscences unexecused	-0.029	0.014	0.037	-0.002	Abscences unexecused	-0.027	0.014	0.049
Gender	0.258	0.144	0.072	0.002	Gender	0.256	0.144	0.075
GATE program	-1.341	0.211	0.000	0.015	GATE program	-1.356	0.211	0.000
Lang program	0.611	0.217	0.005	-0.004	Lang program	0.615	0.217	0.005
Econ 3	-2.236	0.538	0.000	-0.008	Econ 3	-2.228	0.536	0.000
School characteristics					School characteristics			
Vintage	0.034	0.008	0.000	-0.001	Vintage	0.035	0.008	0.000
School site					School site			
SCH 59	-1.607	0.391	0.000	0.018	SCH 59	-1.625	0.391	0.000
SCH 60	-1.434	0.408	0.000	-0.086	SCH 60	-1.348	0.408	0.001
SCH 62	0.670	0.389	0.085	-0.242	SCH 62	0.912	0.384	0.017
SCH 69	-0.886	0.336	0.008	-0.097	SCH 69	-0.788	0.336	0.019
SCH 72	-2.206	0.337	0.000	0.087	SCH 72	-2.293	0.337	0.000
SCH 74	-0.963	0.418	0.021	-0.268	SCH 74	-0.695	0.416	0.094
SCH 77	0.890	0.367	0.015	-0.024	SCH 77	0.914	0.367	0.013
SCH 78	-0.824	0.356	0.021	0.001	SCH 78	-0.825	0.353	0.020
SCH 79	0.848	0.470	0.071	0.049	SCH79	0.799	0.470	0.089
SCH 82	1.264	0.424	0.003	-0.006	SCH82	1.270	0.424	0.003
SCH 84	-0.663	0.410	0.106	-0.001	SCH 84	-0.662	0.410	0.107
Outliers					Outliers			
O 33	34.133	6.868	0.000	0.102	O 33	34.031	6.877	0.000
O 18	34.905	6.861	0.000	0.061	O 18	34.844	6.870	0.000
O 32	62.516	6.866	0.000	-0.514	O 32	63.030	6.874	0.000
O 48	(46.018)	6.864	0.000	0.497	O 48	-46.516	6.870	0.000
O 45	(40.246)	6.860	0.000	0.275	O 45	-40.521	6.868	0.000
O 77	(36.783)	6.861	0.000	0.140	O 77	-36.924	6.870	0.000
O 02	(33.621)	6.869	0.000	0.287	O 02	-33.908	6.877	0.000
Dependent Variable: MATHDELT					Dependent Variable: MATHDELT			

Figure 27 - Capistrano Math Model, Expanded Population, with and without Teacher Variables

Descriptive Statistics Capistrano Original Population

	N	Minimum	Maximum	Mean	Std. Dev.
Daylight Code	8268	0.000	5.000	2.029	1.241
Window Code	8268	0.000	5.000	1.364	1.093
Skylight Type A	8268	0.000	1.000	0.060	0.237
Skylight Type AA	8268	0.000	1.000	0.034	0.181
Skylight Type D	8268	0.000	1.000	0.013	0.113
Skylight Type C	8268	0.000	1.000	0.042	0.201
Skylight Type B	8268	0.000	1.000	0.041	0.197
Operable Windows	8268	0.000	1.000	0.607	0.488
Teacher 1	8268	0.000	1.000	0.295	0.456
Teacher 2	8268	0.000	1.000	0.175	0.380
Teacher 3	8268	0.000	1.000	0.182	0.386
Teacher 4	8268	0.000	1.000	0.054	0.226
Teacher 6	8268	0.000	1.000	0.101	0.301
Teacher 5	8268	0.000	1.000	0.067	0.251
Teacher 7	8268	0.000	1.000	0.179	0.384
Log yrs teaching	8268	0.000	42.000	6.641	9.190
School Pop-per 500	8268	404.000	1518.000	879.430	201.472
Classroom Pop	8268	5.000	44.000	23.896	5.886
Grade 2	8268	0.000	1.000	0.268	0.443
Grade 3	8268	0.000	1.000	0.245	0.430
Grade 4	8268	0.000	1.000	0.250	0.433
Vintage	8268	2.000	64.000	17.666	13.295
Absences Unverified - per 10	8268	0.000	12.000	0.107	0.622
Absences Unexcused -per 10	8268	0.000	60.000	5.325	5.361
Tardies	8268	0.000	105.000	4.740	8.540
Gender	8268	0.000	1.000	0.509	0.500
Ethnic 4	8268	0.000	1.000	0.003	0.050
Ethnic 1	8268	0.000	1.000	0.050	0.218
Ethnic 6	8268	0.000	1.000	0.013	0.111
Ethnic 3	8268	0.000	1.000	0.147	0.354
Ethnic 2	8268	0.000	1.000	0.015	0.121
Ethnic 7	8268	0.000	1.000	0.002	0.040
GATE program	8268	0.000	1.000	0.135	0.342
Lang program	8268	0.000	1.000	0.172	0.377
Econ 3	8268	0.000	1.000	0.147	0.203
Econ	8268	0.000	1.000	0.087	0.282
Sch 59	8268	0.000	1.000	0.032	0.176
Sch 60	8268	0.000	1.000	0.041	0.198
Sch 61	8268	0.000	1.000	0.067	0.251
Sch 62	8268	0.000	1.000	0.043	0.204
Sch 64	8268	0.000	1.000	0.020	0.142
Sch 66	8268	0.000	1.000	0.032	0.176
Sch 67	8268	0.000	1.000	0.053	0.224
Sch 69	8268	0.000	1.000	0.064	0.245
Sch 70	8268	0.000	1.000	0.035	0.185
Sch 71	8268	0.000	1.000	0.034	0.180
Sch 72	8268	0.000	1.000	0.066	0.248
Sch 74	8268	0.000	1.000	0.043	0.202
Sch 76	8268	0.000	1.000	0.046	0.210
Sch 77	8268	0.000	1.000	0.050	0.218
Sch 78	8268	0.000	1.000	0.043	0.203
Sch 79	8268	0.000	1.000	0.041	0.198
Sch 81	8268	0.000	1.000	0.056	0.229
Sch 82	8268	0.000	1.000	0.043	0.203
Sch 84	8268	0.000	1.000	0.029	0.169
Sch 85	8268	0.000	1.000	0.062	0.241
Sch 173	8268	0.000	1.000	0.031	0.172
Sch 273	8268	0.000	1.000	0.024	0.152
Valid N (listwise)	8268				

Figure 28 - Descriptive Statistics, Capistrano Original Population

Descriptive Statistics Capistrano Teacher Survey Population

	N	Minimum	Maximum	Mean	Std. Deviation
Math Delta	3889	-29.000	79.000	13.128	8.091
Reading Delta	3899	-22.000	59.000	9.251	9.399
Daylight code	3949	0.000	5.000	2.222	1.329
Operable windows	3949	0.000	1.000	0.551	0.498
School Pop-per 500	3949	404.000	1518.000	896.234	204.224
Classroom Pop	3949	11.000	34.000	23.838	5.766
Vintage	3949	2.000	64.000	18.112	13.796
Grade 2	3949	0.000	1.000	0.294	0.456
Grade 3	3949	0.000	1.000	0.243	0.429
Grade 4	3949	0.000	1.000	0.243	0.429
Absences Unverified	3949	0.000	11.000	0.070	0.517
Absences Unexcused	3949	0.000	60.000	5.043	5.502
Tardies	3949	0.000	73.000	4.707	8.503
Gender	3949	0.000	1.000	0.514	0.500
Ethnic 4	3949	0.000	1.000	0.002	0.042
Ethnic 1	3949	0.000	1.000	0.051	0.221
Ethnic 6	3949	0.000	1.000	0.011	0.106
Ethnic 3	3949	0.000	1.000	0.150	0.357
Ethnic 2	3949	0.000	1.000	0.011	0.106
Ethnic 7	3949	0.000	1.000	0.002	0.039
GATE program	3949	0.000	1.000	0.130	0.336
Lang program	3949	0.000	1.000	0.174	0.380
Econ 3	3949	0.000	0.960	0.165	0.212
Log yrs teaching	3949	0.693	3.738	2.462	0.663
Teacher 1	3949	0.000	1.000	0.241	0.428
Teacher 2	3949	0.000	1.000	0.343	0.475
Teacher 3	3949	0.000	1.000	0.290	0.454
Teacher 4	3949	0.000	1.000	0.126	0.332
Teacher 6	3949	0.000	1.000	0.232	0.422
Teacher 7	3949	0.000	1.000	0.399	0.490
Sch 59	3949	0.000	1.000	0.028	0.165
Sch 60	3949	0.000	1.000	0.047	0.211
Sch 61	3949	0.000	1.000	0.060	0.238
Sch 62	3949	0.000	1.000	0.064	0.244
Sch 64	3949	0.000	1.000	0.022	0.145
Sch 65	3949	0.000	1.000	0.046	0.209
Sch 66	3949	0.000	1.000	0.039	0.194
Sch 67	3949	0.000	1.000	0.058	0.234
Sch 68	3949	0.000	1.000	0.045	0.207
Sch 69	3949	0.000	1.000	0.041	0.197
Sch 70	3949	0.000	1.000	0.004	0.062
Sch 72	3949	0.000	1.000	0.049	0.215
Sch 74	3949	0.000	1.000	0.046	0.210
Sch 76	3949	0.000	1.000	0.033	0.178
Sch 77	3949	0.000	1.000	0.036	0.186
Sch 78	3949	0.000	1.000	0.059	0.236
Sch 79	3949	0.000	1.000	0.020	0.139
Sch 81	3949	0.000	1.000	0.065	0.247
Sch 82	3949	0.000	1.000	0.030	0.171
Sch 83	3949	0.000	1.000	0.063	0.244
Sch 84	3949	0.000	1.000	0.031	0.172
Sch 85	3949	0.000	1.000	0.059	0.236
Sch 93	3949	0.000	1.000	0.032	0.176
Sch 94	3949	0.000	1.000	0.025	0.155
Valid N (listwise)	3862				

Figure 29 - Descriptive Statistics, Capistrano Teacher Survey Population

Descriptive Statistics Capistrano Expanded Population

	N	Minimum	Maximum	Mean	Std. Deviation
Math Delta	9186	-29.000	79.000	12.565	7.914
Reading Delta	9195	-22.000	59.000	8.771	9.010
Daylight Code	9302	0.000	5.000	1.977	1.240
Operable Windows	9302	0.000	1.000	0.574	0.495
School Pop-per 500	9302	404.000	1518.000	886.693	190.423
Classroom Pop	9302	5.000	44.000	23.880	5.885
Grade 2	9302	0.000	1.000	0.273	0.446
Grade 3	9302	0.000	1.000	0.244	0.429
Grade 4	9302	0.000	1.000	0.248	0.432
Absences Unverified	9302	0.000	12.000	0.094	0.584
Absences Unexcused	9302	0.000	60.000	4.672	5.324
Tardies	9302	0.000	105.000	4.143	8.146
Gender	9302	0.000	1.000	0.508	0.500
Vintage	9302	2.000	64.000	16.844	13.157
Ethnic 4	9302	0.000	1.000	0.002	0.047
Ethnic 1	9302	0.000	1.000	0.052	0.222
Ethnic 6	9302	0.000	1.000	0.012	0.110
Ethnic 3	9302	0.000	1.000	0.139	0.346
Ethnic 2	9302	0.000	1.000	0.014	0.117
Ethnic 7	9302	0.000	1.000	0.002	0.041
GATE program	9302	0.000	1.000	0.138	0.345
Lang program	9302	0.000	1.000	0.164	0.371
Econ 3	9302	0.000	1.000	0.153	0.199
Teacher 1	9302	0.000	1.000	0.248	0.432
Teacher 3	9302	0.000	1.000	0.177	0.381
Teacher 2	9302	0.000	1.000	0.146	0.353
Teacher 4	9302	0.000	1.000	0.053	0.225
Teacher 5	9302	0.000	1.000	0.052	0.222
Teacher 6	9302	0.000	1.000	0.098	0.298
Teacher 7	9302	0.000	1.000	0.170	0.375
Log yrs teaching	9302	0.000	3.738	1.045	1.291
Sch 59	9302	0.000	1.000	0.038	0.191
Sch 60	9302	0.000	1.000	0.038	0.191
Sch 61	9302	0.000	1.000	0.048	0.213
Sch 62	9302	0.000	1.000	0.042	0.200
Sch 64	9302	0.000	1.000	0.018	0.134
Sch 66	9302	0.000	1.000	0.028	0.164
Sch 67	9302	0.000	1.000	0.046	0.209
Sch 68	9302	0.000	1.000	0.033	0.179
Sch 69	9302	0.000	1.000	0.055	0.228
Sch 70	9302	0.000	1.000	0.032	0.177
Sch 71	9302	0.000	1.000	0.031	0.172
Sch 72	9302	0.000	1.000	0.053	0.225
Sch 74	9302	0.000	1.000	0.033	0.179
Sch 76	9302	0.000	1.000	0.043	0.203
Sch 77	9302	0.000	1.000	0.047	0.211
Sch 78	9302	0.000	1.000	0.048	0.214
Sch 79	9302	0.000	1.000	0.026	0.159
Sch 80	9302	0.000	1.000	0.045	0.207
Sch 81	9302	0.000	1.000	0.043	0.203
Sch 82	9302	0.000	1.000	0.035	0.183
Sch 83	9302	0.000	1.000	0.045	0.207
Sch 84	9302	0.000	1.000	0.040	0.196
Sch 85	9302	0.000	1.000	0.051	0.219
Sch 93	9302	0.000	1.000	0.030	0.171
Sch 94	9302	0.000	1.000	0.021	0.142
Valid N (listwise)	9123				

Figure 30 - Descriptive Statistics, Capistrano Expanded Population

7.4 Grade Level Models

New Model				Change	Old Model			
Capistrano Grade Level Interaction	Reading Daylight			new-old	Capistrano, Original Analysis	Reading Daylight		
CGL6-rd				R^2	C17-rd			
Model R^2	**0.239**			**-0.007**	**Model R^2**	**0.246**		
	B	Std. Error	p (Signif)	B		B	Std. Error	p (Signif)
(Constant)	2.774	0.399	0.000		(Constant)	3.025	0.298	0.000
Classroom Characteristics					Classroom Characteristics			
Daylight Code	**0.396**	**0.080**	**0.000**	**-0.068**	**Daylight code**	**0.464**	**0.085**	**0.000**
					Operable Window	0.643	0.212	0.002
Teacher Characteristics								
Teacher 1	-1.148	0.493	0.020					
Teacher 2	1.134	0.344	0.001					
Teacher 6	0.625	0.308	0.043					
Student Characteristics					Student Characteristics			
Grade 2	12.478	1.041	0.000	1.618	Grade 2	10.860	0.251	0.000
Grade 3	5.819	1.432	0.000	1.521	Grade 3	4.298	0.254	0.000
				-0.937	Grade 4	0.937	0.252	0.000
Ethnic 6	1.306	0.746	0.080					
GATE Program	1.086	0.485	0.025	2.537	GATE Program	-1.452	0.257	0.000
Lang Prog	0.441	0.525	0.400	-0.397	Lang Prog	0.838	0.239	0.000
Econ 3	-4.077	1.307	0.002					
School Characteristics					School Characteristics			
Vintage	0.054	0.011	0.000					
School Site					School Site			
Sch 61	1.888	0.472	0.000	-0.307	Sch 61	2.195	0.370	0.000
Sch 62	0.986	0.478	0.039	-0.598	Sch 62	1.584	0.477	0.001
Sch 64	3.207	0.933	0.001	0.690	Sch 64	2.517	0.638	0.000
Sch 67	0.827	0.436	0.058	-0.532	Sch 67	1.359	0.416	0.001
Sch 70	2.277	0.923	0.014					
Sch 72	-1.262	0.402	0.002	0.198	Sch 72	-1.460	0.376	0.000
Sch 77	0.792	0.423	0.061	-0.070	Sch 77	0.863	0.428	0.044
Sch 79	1.078	0.542	0.047					
Sch 81	2.261	0.477	0.000	1.271	Sch 81	0.990	0.431	0.022
Sch 82	2.179	0.492	0.000	0.511	Sch 82	1.668	0.449	0.000
					Sch 85	-1.254	0.388	0.001
Sch 73	1.518	0.490	0.002	-0.009	Sch 73	1.528	0.516	0.003
Outliers					Outliers			
O82	37.789	7.800	0.000	-3.559	O82	39.650	7.916	0.000
O71	40.147	7.798	0.000	-0.533	O71	40.680	7.925	0.000
O17	40.288	7.803	0.000	0.638	O17	41.348	7.922	0.000
O28	-36.386	7.807	0.000	1.084	O28	-37.470	7.926	0.000
O80	-38.527	7.798	0.000		O58	35.564	7.923	0.000
O69	-31.246	7.806	0.000		O50	36.543	7.915	0.000
Interaction Variables					Dependent Variable: Reading Delta (sp98-fa97)			
OPWIN_2	0.659	0.341	0.053					
CLSPOP_4	0.122	0.060	0.041					
ABUNVE_4	0.656	0.305	0.031					
ABUNEX_2	0.061	0.031	0.048					
Gender 2	-1.234	0.460	0.007					
GATE_2	-6.856	0.691	0.000					
GATE_3	-3.016	0.671	0.000					
LANGPR_2	-1.296	0.719	0.072					
LANGPR_3	1.350	0.715	0.059					
Econ 3-2	3.411	1.622	0.036					
Teach 1-2	1.722	0.567	0.002					
Teach 3-2	-2.351	0.650	0.000					
Dependent Variable: READDELT								

Figure 31- Capistrano Grade Level Interaction, Reading Daylight

New Model				Change	Old Model			
Capistrano Grade Level Interaction	Math Daylight			new-old	Capistrano, Original Analysis	Math Daylight		
CGL6-md				R^2	C17-md			
Model R^2	**0.261**			**0.005**	**Model R^2**	**0.256**		
	B	Std. Error	p (Signif)	B		B	Std. Error	p (Signif)
(Constant)	7.787	0.481	0.000		(Constant)	8.026	0.407	0.000
Classroom Characteristics					Classroom Characteristics			
Daylight Code	**0.275**	**0.154**	**0.073**	**-0.229**	**Daylight Code**	**0.504**	**0.067**	**0.000**
Daylight Code*2nd Grade	0.320	0.190	0.093					
Teacher Characteristics					Teacher Characteristics			
none significant								
Student Characteristics					Student Characteristics			
Grade 2	11.506	0.871	0.000	1.794	SECOND	9.711	0.215	0.000
Grade 3	3.227	0.893	0.000	-2.704	THIRD	5.931	0.219	0.000
Grade 4	2.451	0.922	0.008	0.637	FOURTH	1.813	0.216	0.000
Gender	0.277	0.143	0.053					
GATE program	(1.352)	0.211	0.000	-0.115	GATE progam	-1.236	0.223	0.000
LANG program	0.566	0.216	0.009	0.077	LANG program	0.490	0.205	0.017
Econ 3	(2.390)	0.907	0.008					
					Absen Unver	-0.263	0.123	0.032
Absen Unexc	(0.030)	0.014	0.034	-0.004	Absen Unexc	-0.026	0.014	0.069
School Characteristics								
Vintage	0.038	0.014	0.008	0.038				
School Site					School Site			
SCH59	(1.818)	0.390	0.000	-0.728	SCH59	-1.089	0.435	0.012
SCH60	(1.390)	0.411	0.001					
				-0.898	SCH61	0.898	0.313	0.004
SCH62	0.644	0.387	0.096	-0.804	SCH62	1.448	0.395	0.000
					SCH67	0.838	0.355	0.018
SCH69	(0.748)	0.341	0.028					
				-0.803	SCH71	0.803	0.429	0.061
SCH72	(2.815)	0.359	0.000	-1.201	SCH72	-1.613	0.321	0.000
SCH74	(0.936)	0.421	0.026					
SCH77	0.797	0.364	0.029	-0.370	SCH77	1.167	0.365	0.001
SCH78	(0.930)	0.362	0.010					
SCH82	0.944	0.427	0.027	-0.255	SCH82	1.198	0.379	0.002
SCH84	(0.932)	0.401	0.020					
Outliers					Outliers			
O33	34.480	6.836	0.000	0.418	O33	34.062	6.838	0.000
O18	33.983	6.831	0.000	-1.132	O18	35.115	6.837	0.000
O32	61.652	6.837	0.000	-0.803	O32	62.456	6.835	0.000
O48	(46.429)	6.829	0.000	-0.007	O48	-46.422	6.831	0.000
O45	(40.698)	6.828	0.000	-0.388	O45	-40.310	6.830	0.000
O77	(35.628)	6.832	0.000					
O02	(32.938)	6.840	0.000	1.529	O02	-34.466	6.830	0.000
Interaction Variables					Dependent Variable: MATHDELT			
Vintage 2	(0.046)	0.020	0.021					
Vintage 3	0.057	0.019	0.003					
Vintage 4	(0.063)	0.020	0.001					
School Pop 2	(0.003)	0.001	0.000					
School Pop 3	0.002	0.001	0.003					
Tardies 2	(0.030)	0.017	0.078					
Tardies 3	0.047	0.017	0.006					
Econ 3-3	(3.135)	1.190	0.008					
a Econ 3-4	3.387	1.258	0.007					
Teach 1-2	2.140	0.322	0.000					
Teach 4-4	2.914	1.292	0.024					
Dependent Variable: MATHDELT								

Figure 32- Capistrano Grade Level Interaction, Math Daylight

New Model				Change	Old Model			
Seattle Grade Level Interaction		Reading Daylight		new-old	Seattle, orginal analysis		Reading Daylight	
GL2-rd				R^2	S9-rd			
Model R^2	**0.337**			**0.040**	**Model R^2**	**0.297**		
	B	Std. Error	p (Signif)	B		B	Std. Error	p (Signif)
(Constant)	52.107	2.196	0.000		(Constant)	54.667	1.726	0.000
Classroom Characteristics					Classroom Characteristics			
Daylight Code	**2.533**	**0.373**	**0.000**	**0.650**	**Daylight Code**	**1.883**	**0.342**	**0.000**
					Portable	-2.123	1.121	0.058
Gifted room (70%+)	16.153	1.563	0.000	0.812	Gifted room (70%+)	15.342	0.894	0.000
				0.002	Class SF	-0.002	0.000	0.001
Students per Class	0.157	0.024	0.000	0.020	Students per Class	0.137	0.025	0.000
Student Characteristics					Student Characteristics			
Grade 2	15.056	2.491	0.000	8.098	Grade 2	6.957	0.596	0.000
				2.074	Grade 3	-2.074	0.523	0.000
				-0.949	Grade 4	0.949	0.529	0.073
Ethnic 2	-9.870	0.891	0.000	-1.409	Ethnic 2	-8.461	0.522	0.000
Ethnic 4	-11.016	0.550	0.000	0.152	Ethnic 4	-11.168	0.557	0.000
Ethnic 1	-8.534	1.293	0.000	-0.768	Ethnic 1	-7.766	0.797	0.000
Ethnic 3	-6.165	1.349	0.000	0.394	Ethnic 3	-6.559	1.336	0.000
				-0.912	Gender	0.912	0.380	0.016
Econ 2	-10.939	0.446	0.000	-2.264	Econ 2	-8.675	0.475	0.000
Socio 1	-3.311	1.095	0.003	1.169	Socio 1	-4.481	1.131	0.000
Socio 3	-1.616	0.452	0.000	1.001	Socio 3	-2.618	0.480	0.000
Socio 2	-1.949	0.976	0.046	1.233	Socio 2	-3.182	1.011	0.002
School Characteristics					School Characteristics			
School Pop - per 500	5.574	3.215	0.083	-1.088	School Pop - per 500	6.662	1.762	0.000
Outliers					Outliers			
O26	-63.880	16.619	0.000	1.534	O26	-65.414	16.407	0.000
O64	-66.614	16.613	0.000	1.313	O64	-67.927	16.409	0.000
O07	-68.420	16.626	0.000	1.812	O07	-70.231	16.408	0.000
O73	-72.856	16.612	0.000	-1.715	O73	-71.141	16.408	0.000
O21	-64.758	16.617	0.000	0.457	O21	-65.215	16.413	0.000
Interaction Variables					Dependent Variable: Reading NCE 98			
VINT_2ND	-0.089	0.017	0.000					
SCSZ_2ND	-0.038	0.010	0.000					
SCSZ_4TH	0.017	0.009	0.070					
Gen_2ND	4.345	1.046	0.000					
Gen_3RD	1.858	0.994	0.062					
SQFT_3RD	-0.002	0.001	0.003					
SQFT_4TH	-0.001	0.001	0.071					
Eth2_3RD	-2.191	1.173	0.062					
Eth2_4TH	-3.055	1.216	0.012					
Eth1_3RD	-5.227	1.916	0.006					
Dependent Variable: Reading NCE 98								

Figure 33- Seattle Grade Level Interaction, Reading Daylight

New Model				Change	Old Model			
Seattle Grade Level Interaction	Math Daylight			new-old	Seattle, original anlysis	Math Daylight		
SGL2-md				R^2	S9-md			
Model R^2	**0.257**			**-0.001**	**Model R^2**	**0.258**		Sig.
	B	Std. Error	p (Signif)	B		B	Std. Error	p (Signif)
(Constant)	49.134	2.073	0.000		(Constant)	55.653	1.841	0.000
Classroom Characteristics					Classroom Characteristics			
Daylight Code	**1.585**	**0.438**	**0.000**	**0.194**	**Daylight Code**	**1.391**	**0.436**	**0.001**
Open room	3.485	1.650	0.035	-0.022	Open room	3.506	1.579	0.026
Portable	-2.496	1.174	0.033	0.562	Portable	-3.058	1.171	0.009
Gifted room (70%+)	16.312	0.931	0.000	-0.082	Gifted room (70%+)	16.394	0.931	0.000
Class SF	-0.003	0.001	0.003	-0.002	Class SF	-0.001	0.001	0.063
Students per Class	0.185	0.054	0.001	0.119	Students per Class	0.066	0.033	0.044
Student Characteristics					Student Characteristics			
Grade 2	22.935	2.612	0.000	16.832	Grade 2	6.104	0.577	0.000
Grade 3	5.013	2.336	0.032	8.401	Grade 3	-3.388	0.477	0.000
Ethnic 4	-11.440	0.537	0.000	0.011	Ethnic 4	-11.452	0.538	0.000
Ethnic 1	-5.564	0.800	0.000	-0.087	Ethnic 1	-5.477	0.803	0.000
Ethnic 3	-6.974	1.376	0.000	0.004	Ethnic 3	-6.978	1.381	0.000
Gender	-2.957	0.390	0.000	0.060	Gender	-3.017	0.392	0.000
Econ 2	-5.756	0.474	0.000	0.035	Econ 2	-5.790	0.475	0.000
Socio 1	-4.408	1.163	0.000	-0.069	Socio 1	-4.339	1.167	0.000
Socio 3	-3.525	0.835	0.000	-0.418	Socio 3	-3.107	0.494	0.000
Socio 2	-4.769	1.053	0.000	-0.078	Socio 2	-4.691	1.057	0.000
School Characteristics					School Characteristics			
Vintage	0.053	0.015	0.001	0.036	Vintage	0.017	0.010	0.098
School Pop-per 500	21.459	3.081	0.000	9.937	School Pop-per 500	11.522	2.065	0.000
Outliers					Outliers			
O10143	-61.856	16.787	0.000	3.117	O10143	-64.973	16.814	0.000
O9223	57.790	16.748	0.001	-0.259	O9223	58.049	16.824	0.001
O13206	49.760	16.751	0.003	-4.640	O13206	54.400	16.802	0.001
Interaction Variables					Dependent Variable: Math NCE 98			
SCSZ_2ND	-0.061	0.010	0.000					
SCSZ_3RD	-0.035	0.009	0.000					
VINT_2ND	-0.121	0.022	0.000					
VINT_3RD	-0.037	0.021	0.077					
CLSZ_4TH	-0.205	0.067	0.002					
SQFT_2ND	0.002	0.001	0.079					
SQFT_4TH	0.003	0.001	0.013					
Dependent Variable: Math NCE 98								

Figure 34 - Seattle Grade Level Interaction, Math Daylight

Descriptive Statistics Capistrano Grade Level, Reading and Math

	N	Minimum	Maximum	Mean	Std. Dev.
READDELT	9195	-22.000	59.000	8.771	9.010
MATHDELT	9186	-29.000	79.000	12.565	7.914
Daylight Code	9302	0.000	5.000	1.977	1.240
Teacher 1	9302	0.000	1.000	0.248	0.432
Teacher 3	9302	0.000	1.000	0.177	0.381
Teacher 2	9302	0.000	1.000	0.146	0.353
Teacher 6	9302	0.000	1.000	0.098	0.298
Log yrs teaching	9302	0.000	3.738	1.045	1.291
Grade 2	9302	0.000	1.000	0.273	0.446
Grade 3	9302	0.000	1.000	0.244	0.429
Grade 4	9302	0.000	1.000	0.248	0.432
Vintage	9302	2.000	64.000	16.844	13.157
Gender	9302	0.000	1.000	0.508	0.500
Ethnic 6	9302	0.000	1.000	0.012	0.110
GATE program	9302	0.000	1.000	0.138	0.345
Lang program	9302	0.000	1.000	0.164	0.371
Econ 3	9302	0.000	1.000	0.153	0.199
Sch 61	9302	0.000	1.000	0.048	0.213
Sch 62	9302	0.000	1.000	0.042	0.200
Sch 64	9302	0.000	1.000	0.018	0.134
Sch 67	9302	0.000	1.000	0.046	0.209
Sch 70	9302	0.000	1.000	0.032	0.177
Sch 71	9302	0.000	1.000	0.031	0.172
Sch 72	9302	0.000	1.000	0.053	0.225
Sch 77	9302	0.000	1.000	0.047	0.211
Sch 79	9302	0.000	1.000	0.026	0.159
Sch 81	9302	0.000	1.000	0.043	0.203
Sch 82	9302	0.000	1.000	0.035	0.183
Sch 173	9302	0.000	1.000	0.030	0.171
Valid N (listwise)	9123				

Figure 35- Descriptive statistics, Capistrano Grade Level, Reading and Math

Descriptive Statistics Seattle Grade Level, Reading

	N	Minimum	Maximum	Mean	Std. Dev.
Reading NCE 98	7538	1.000	99.000	57.350	19.518
Daylight Code	7590	1.000	5.000	3.053	0.752
Portable	7617	0.000	1.000	0.030	0.171
Class SF	7617	638.000	3616.000	1110.707	688.906
Gifted room (70%+)	7617	0.000	1.000	0.049	0.216
Students per Class	7600	5.000	80.000	24.025	13.238
Students per School	7617	44.000	308.000	190.663	57.653
Grade 2	7617	0.000	1.000	0.214	0.410
Grade 3	7617	0.000	1.000	0.270	0.444
Grade 4	7617	0.000	1.000	0.249	0.432
Ethnic 2	7617	0.000	1.000	0.214	0.410
Ethnic 4	7617	0.000	1.000	0.227	0.419
Ethnic 1	7617	0.000	1.000	0.066	0.249
Ethnic 3	7617	0.000	1.000	0.021	0.144
Gender	7614	0.000	1.000	0.512	0.500
Econ 2	7617	0.000	1.000	0.405	0.491
Socio 1	7617	0.000	1.000	0.030	0.172
Socio 3	7617	0.000	1.000	0.288	0.453
Socio 2	7617	0.000	1.000	0.043	0.202

Figure 36- Descriptive statistics, Seattle Grade Level, Reading

Descriptive Statistics Seattle Grade Level, Math

	N	Minimum	Maximum	Mean	Std. Dev.
Math NCE 98	7422	1.000	99.000	58.820	19.467
Daylight code	7590	1.000	5.000	3.053	0.752
Open room	7617	0.000	1.000	0.104	0.306
Portable	7617	0.000	1.000	0.030	0.171
Gifted room (70%+)	7617	0.000	1.000	0.049	0.216
Vintage	7617	7.000	92.000	39.812	26.370
Class SF	7617	638.000	3616.000	1110.707	688.906
Students per Class	7600	5.000	80.000	24.025	13.238
Students per School	7617	44.000	308.000	190.663	57.653
Grade 2	7617	0.000	1.000	0.214	0.410
Grade 3	7617	0.000	1.000	0.270	0.444
Ethnic 4	7617	0.000	1.000	0.227	0.419
Ethnic 1	7617	0.000	1.000	0.066	0.249
Ethnic 3	7617	0.000	1.000	0.021	0.144
Gender	7614	0.000	1.000	0.512	0.500
Econ 2	7617	0.000	1.000	0.405	0.491
Socio 1	7617	0.000	1.000	0.030	0.172
Socio 3	7617	0.000	1.000	0.288	0.453
Socio 2	7617	0.000	1.000	0.043	0.202
Valid N (listwise)	7379				

Figure 37- Descriptive statistics, Seattle Grade Level, Math

7.5 Absenteeism Models

Capistrano Absenteeism Analysis
ABS 3 LN
Model R^2 0.049

		Std. Error	Beta	t	p (Signif)
	1.651	0.061		27.050	0.000
1 (Constant)					
Classroom characteristics	-0.059	0.029	-0.026	-2.025	0.043
Semi-open classroom					
Student characteristics	-0.056	0.022	-0.029	-2.564	0.010
Grade 3	-0.042	0.021	-0.022	-1.975	0.048
Grade 4	0.035	0.017	0.021	2.038	0.042
Gender	-0.470	0.042	-0.122	-11.217	0.000
Ethnic 1	-0.144	0.079	-0.019	-1.823	0.068
Ethnic 6	-0.223	0.073	-0.032	-3.038	0.002
Ethnic 2	-0.396	0.198	-0.021	-1.997	0.046
Ethnic 7	-0.100	0.027	-0.040	-3.777	0.000
GATE program	-0.154	0.027	-0.073	-5.676	0.000
Lang program	0.213	0.105	0.059	2.026	0.043
Econ 3					
School characteristics	0.006	0.001	0.093	4.377	0.000
Vintage	0.000	0.000	0.029	2.004	0.045
School Pop-per 500					
School sites	-0.105	0.047	-0.025	-2.260	0.024
Sch 59	-0.150	0.050	-0.036	-3.017	0.003
Sch 60	0.112	0.047	0.028	2.386	0.017
Sch 62	-0.454	0.081	-0.094	-5.585	0.000
Sch 64	-0.105	0.044	-0.028	-2.414	0.016
Sch 67	-0.256	0.085	-0.066	-3.020	0.003
Sch 70	-0.151	0.052	-0.034	-2.909	0.004
Sch 74	0.130	0.060	0.026	2.173	0.030
Sch 79	0.092	0.049	0.023	1.867	0.062
Sch 81	0.291	0.051	0.067	5.703	0.000
Sch 82	0.094	0.047	0.024	1.991	0.047
Sch 84	0.182	0.056	0.039	3.244	0.001
Sch 173					
Outliers	2.528	0.815	0.032	3.102	0.002
O 49					
Dependent Variable: Log of Absence days					

Figure 38 - Capistrano Absenteeism Model

Capistrano Tardiness Model
ABS 3 LN

	B	Std. Error	Beta	t	p (Signif)
Model R^2	**0.097**				
1 (Constant)	1.305	0.096		13.623	0.000
Classroom characteristics					
Daylight code	-0.046	0.012	-0.050	-3.945	0.000
No air conditioning	0.113	0.053	0.029	2.144	0.032
Portable classroom	0.054	0.026	0.024	2.087	0.037
Teacher characteristics					
Teacher 1	0.199	0.039	0.080	5.172	0.000
Teacher 3	0.238	0.045	0.084	5.236	0.000
Teacher 7	-0.081	0.036	-0.028	-2.236	0.025
Log yrs teaching	-0.006	0.002	-0.054	-3.065	0.002
Student characteristics					
Grade 2	0.050	0.025	0.021	2.021	0.043
Ethnic 4	0.545	0.217	0.026	2.515	0.012
Ethnic 1	-0.197	0.052	-0.039	-3.803	0.000
Ethnic 3	0.160	0.037	0.055	4.327	0.000
Ethnic 2	0.424	0.093	0.046	4.541	0.000
GATE program	-0.231	0.034	-0.071	-6.839	0.000
Econ 3	0.586	0.126	0.125	4.663	0.000
School characterisics					
School Pop-per 500	0.000	0.000	-0.053	-3.189	0.001
School sites					
Sch 59	-0.393	0.060	-0.072	-6.552	0.000
Sch 60	-0.102	0.061	-0.019	-1.670	0.095
Sch 61	0.261	0.058	0.054	4.498	0.000
Sch 64	0.455	0.106	0.072	4.294	0.000
Sch 67	-0.183	0.053	-0.038	-3.434	0.001
Sch 70	-0.582	0.115	-0.114	-5.069	0.000
Sch 71	0.140	0.069	0.023	2.028	0.043
Sch 72	-0.219	0.053	-0.048	-4.163	0.000
Sch 74	-0.488	0.067	-0.084	-7.255	0.000
Sch 76	-0.183	0.058	-0.035	-3.165	0.002
Sch 84	0.161	0.055	0.031	2.901	0.004
Sch 173	0.337	0.074	0.055	4.529	0.000
Sch 273	0.207	0.092	0.028	2.253	0.024

Dependent Variable: LNYI_T

Figure 39 - Capistrano Tardiness Model

Absenteeism/Tardiness Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Daylight code	8808	0.000	5.000	1.983	1.197
No Air conditioning	8808	0.000	1.000	0.087	0.282
Semi-open classroom	8808	0.000	1.000	0.162	0.369
Portable classroom	8808	0.000	1.000	0.403	0.491
Modular classroom	8808	0.000	1.000	0.101	0.302
Teacher 1	8808	0.000	1.000	0.260	0.439
Teacher 2	8808	0.000	1.000	0.152	0.359
Teacher 3	8808	0.000	1.000	0.180	0.384
Teacher 4	8808	0.000	1.000	0.052	0.222
Teacher 6	8808	0.000	1.000	0.099	0.299
Teacher 5	8808	0.000	1.000	0.057	0.232
Teacher 7	8808	0.000	1.000	0.165	0.371
Log yrs teaching	8808	0.000	42.000	6.315	9.219
School Pop-per 500	8808	404.000	1518.000	882.632	201.494
Classroom Pop	8808	6.000	34.000	23.422	5.934
Grade 2	8808	0.000	1.000	0.285	0.451
Grade 3	8808	0.000	1.000	0.237	0.425
Grade 4	8808	0.000	1.000	0.241	0.428
Vintage	8808	2.000	64.000	18.518	14.090
Gender	8808	0.000	1.000	0.509	0.500
Ethnic 4	8808	0.000	1.000	0.003	0.051
Ethnic 1	8808	0.000	1.000	0.049	0.216
Ethnic 6	8808	0.000	1.000	0.012	0.111
Ethnic 3	8808	0.000	1.000	0.168	0.374
Ethnic 2	8808	0.000	1.000	0.014	0.119
Ethnic 7	8808	0.000	1.000	0.002	0.044
GATE program	8808	0.000	1.000	0.130	0.336
Lang program	8808	0.000	1.000	0.190	0.392
Econ 3	8808	0.000	1.000	0.178	0.232
Sch 59	8808	0.000	1.000	0.041	0.199
Sch 60	8808	0.000	1.000	0.042	0.201
Sch 61	8808	0.000	1.000	0.054	0.226
Sch 62	8808	0.000	1.000	0.047	0.211
Sch 64	8808	0.000	1.000	0.031	0.173
Sch 67	8808	0.000	1.000	0.053	0.224
Sch 69	8808	0.000	1.000	0.061	0.240
Sch 70	8808	0.000	1.000	0.048	0.214
Sch 71	8808	0.000	1.000	0.034	0.181
Sch 72	8808	0.000	1.000	0.059	0.236
Sch 74	8808	0.000	1.000	0.036	0.187
Sch 85	8808	0.000	1.000	0.046	0.210
Sch 86	8808	0.000	1.000	0.052	0.221
Sch 87	8808	0.000	1.000	0.053	0.224
Sch 88	8808	0.000	1.000	0.028	0.166
Sch 81	8808	0.000	1.000	0.048	0.213
Sch 82	8808	0.000	1.000	0.038	0.191
Sch 84	8808	0.000	1.000	0.047	0.212
Sch 173	8808	0.000	1.000	0.033	0.179
Sch 273	8808	0.000	1.000	0.022	0.148
O 16	8808	0.000	1.000	0.000	0.011
O 17	8808	0.000	1.000	0.000	0.011
O 15	8808	0.000	1.000	0.000	0.011
O 50	8808	0.000	1.000	0.000	0.011
Valid N (listwise)	8808				

Figure 40 - Capistrano Absenteeism/Tardiness Descriptive Statistics

DAYLIGHTING *initiative*

Design tools and information from The Pacific Gas and Electric Company

Skylighting and Retail Sales

An Investigation into the Relationship Between Daylighting and Human Performance

Condensed Report

August 20, 1999

Submitted to:

George Loisos
Pacific Gas and Electric Company
on behalf of the
California Board for Energy Efficiency Third Party Program

Submitted by:

HESCHONG MAHONE GROUP
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Lisa Heschong, Partner in the Heschong Mahone Group, Fair Oaks, CA, directed the study. She has been assisted at the Heschong Mahone Group by Douglas Mahone, Kalpana Kuttaiah, Nehemiah Stone, Cathy Chappell, Jon McHugh, and Jackie Burton.

Stacia Okura of RLW Analytics, Sonoma, CA, conducted the statistical analysis under the direction of Dr. Roger Wright, Principal, RLW Analytics.

Barbara Erwine of Cascadia Consulting, Seattle, WA, and Michael Holtz of Architectural Energy Corporation, Boulder, CO, participated in initial study design and analysis methodology.

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EXECUTIVE SUMMARY

This study looks at the effect of daylighting on human performance. It specifically focuses on skylighting as a way to isolate daylight as an illumination source, and avoid all of the other qualities associated with daylighting from windows. In this project, we established a statistically compelling connection between skylighting and retail sales, and between daylighting and student performance. This report focuses on the retail analysis.

We analyzed data on the sales performance of a chain retailer that operates a set of nearly identical stores. The analysis included 108 stores, where two thirds of the stores have skylighting and one third do not. The design and operation of all the store sites is remarkably uniform, with the exception of the presence of skylights in some. The electric lighting was primarily fluorescent. Daylight from the skylights often provided more than two-to-three times the target illumination levels. Photo-sensor controls turned off some of the fluorescent lights when daylight levels exceeded target illumination.

The monthly gross sales per store were averaged over an 18-month period that went from February 1 of one year to August 31 of the following year. This average sales figure was transformed into a “sales index” that we could manipulate statistically, but that did not reveal actual dollar performance. Stores in the sample were located within a limited geographic region and had similar climatic conditions. The buildings in the study fell within constrained ranges of size and age. The geographic region has a relatively sunny climate. All of the stores in the data set are one story.

The multivariate regression analysis allowed us to control for the influence of other variables, which might influence sales. Other variables considered included the size and age of the store, hours of operation, and economic characteristics associated with the zip code location.

Skylights were found to be positively and significantly correlated to higher sales. All other things being equal, an average non-skylit store in the chain would likely have 40% higher sales with the addition of skylights, with a probable range between 31% and 49%. This was found with 99% statistical certainty. After the number of hours open per week, the presence of skylights was the best predictor of the sales per store of all the variables that we considered. Thus, if a typical non-skylit store were averaging sales of $2/sf, then its sales might be expected to increase to between $2.61 and $2.98 with the addition of a skylighting system.

The skylights are seen to have a major impact on the overall operation of the chain. Were the chain to add the skylighting system to the remaining 33% of its stores, yearly gross sales are predicted to increase by 11%. The difference between having none of their stores skylit and all their stores skylit is an increase of up to 40% in gross sales for the retail chain.

1. INTRODUCTION

The purpose of this study was to see if we could demonstrate a clear relationship between the presence of daylight and human performance in buildings. We postulated that by focusing on buildings with skylights rather than daylighting from windows, we could isolate the effect of daylight.

In this study, we used a statistical technique called multivariate regression analysis which analyses the importance and impact of many variables simultaneously. The performance data used were gathered from four organizations: one retailer and three school districts. This analysis allowed us to estimate the effect of each of the known variables and to determine which variables have no significant effect. Using this method, we established a statistically compelling connection between skylighting and retail sales, and between daylighting and student performance. This report focuses on the retail analysis.

This Condensed Report is intended for the non-specialist reader. It is a summary of a more extensive report that details the study methodology and statistical analysis. If you have questions about the study that are not answered here, we recommend the Detailed Report.

1.1 Background

Skylights provide a simple illumination function, whereas windows may have a far more complex effect on people. Windows typically offer a view, which may provide relaxation, inspiration or distraction. They are often operable, which may add ventilation, air quality, and thermal comfort issues. Daylight illumination levels from windows are highly variable within a space, and may include components of unacceptable contrast and glare. User control of blinds or curtains also adds another variable that may be hard to account for. Windows are also connected with personal status, and may have psychological implications beyond their mere physical attributes. Skylights would not seem to be as imbued with cultural meaning and don't tend to have as much variability in their function.

Skylighting was a widely used method of providing light to industrial and warehouse buildings before the widespread use of fluorescent lighting. Most single-story industrial buildings built before the 1950's had rows of north-facing roof monitors which allowed ample light into the interior of these large buildings. With the advent of inexpensive fluorescent lighting and air conditioning, daylighting techniques were abandoned in favor of electric lighting.

Recent analysis has shown that skylighting has enormous potential to provide energy savings in single-story commercial buildings. Turning off electric lights when sufficient daylight is available can save a significant amount of lighting energy costs. Because daylight introduces less heat into a building than the equivalent amount of electric light, cooling costs can also be reduced. Analysis has shown that an appropriately sized skylighting system, combined with photosensor controls to turn off unneeded electric lights, will produce net whole building energy savings in almost all parts of the country[1]. Recognizing this, some utilities provided incentive programs to encourage their customers to consider adding skylighting systems to their buildings. Nationally, 40% of all commercial buildings are single-story, and 60% of commercial square footage is directly under a roof[2]. In California, those numbers are even higher, where it is estimated that 90 percent of new construction is single-story[3]. Thus, increased use of skylighting systems could potentially save a considerable amount of energy nationally.

Retail buildings tend to be a fairly straightforward application for skylighting. The trend is towards large, single-story retail centers, with open expanses of shelving; a building type that is well adapted to a skylighting approach. Skylighting in these buildings can save significant amounts of money. For example, a skylighting system in a typical grocery store in Los Angeles has been observed to save about $10,000 per year[4]. A number of national retailers have adopted skylighting as a standard design feature of their stores in order to take advantage of these savings.

With the advent of more skylit stores, anecdotal stories began to surface that stores with skylighting had higher sales. One retailer reported that clothing returns decreased dramatically after installing skylights. In December of 1994 an article appeared on the front page of the Wall Street Journal describing Wal-Mart's experience with adding skylights to their experimental "Eco-Mart" in Lawrence, Kansas[5]. Although no numbers were offered, this article considerably raised the interest level in skylighting for retail applications. It reported that, as a last minute cost saving measure, Wal-Mart had installed skylights in only half of store.

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[1] Analysis with *SkyCalc*, a simulation program, available by downloading from www.energydesignresources.com

[2] Derived from the US Energy Information Agency publication, *Commercial Building Energy Consumption* (CBECs) 1995

[3] Personal communications from PG&E and SDG&E staff.

[4] Per monitoring by PG&E for daylighting case study series, which showed savings of 2kWh/yr per sf for a 50,000sf store paying $0.10/kWh.

[5] "Letting the Sun Shine is Good for Business," John Pierson, *The Wall Street Journal*, November 20, 1995, page B1.

Wal-Mart claims energy savings from drawing natural light through the skylights. But 'something else has gotten the corporation's attention,' says the [Rocky Mountain] Institute. In every Wal-Mart store, each cash register is connected in real time back to headquarters in Bentonville, Ark. According to Tom Scay, who was then the company's vice president for real estate, sales were 'significantly higher' in those departments in the daylit half of the store, and they were also higher there than in the same departments at other stores. Employees in the half without daylighting continue to try to have their departments move to the daylit side."

Such anecdotal studies have been intriguing, but have not offered a measure of how large such a positive effect might be. It has been clear for awhile that the value of such productivity impacts are potentially much greater than energy savings, not only for retailers, but for any business. A building that promises 1% higher productivity is likely to be far more interesting to an owner than a building that is guaranteed to use 10% less energy. Thus, we set out to see if a daylighting effect on performance could be demonstrated and quantified using rigorous statistical techniques.

The implications of the results of this study extend beyond the retail sector. By considering these retail findings with those from the companion study showing improved student performance in daylit classrooms, we can make a case that the beneficial effects of daylight are not likely to be confined to just schools or retail establishments, but rather that human activity in general is likely to benefit from exposure to daylighting.

2. METHODOLOGY

Our interest was to study the potential effect of daylighting on the performance of people in similar buildings with and without skylights. To do this, we sought organizations with pre-existing productivity measurements that could be compared between buildings with and without skylights (or daylight). We began by casting a wide net looking for the ideal organizations that could provide us with data sets amenable to our analysis.

We were looking for organizations that operated at many nearly identical sites, where about half the sites contained skylights and the other half did not. It was important that, other than variations in daylighting, the sites be as identical as possible. They should follow similar operations, and be in similar climates. It was also necessary that there be an on-going measure of performance for each site. We conducted a nationwide search looking for organizations that met these criteria.

The Retailer

We were lucky to find a retailer who met all of these conditions, and was willing to participate in the study. This retailer provided us with basic descriptive information about its stores and a "sales index" for each location. The sales index became the measure of productivity. The retailer, which wishes to remain anonymous, operates a set of nearly identical chain stores that sell a variety of consumer merchandise.

This retailer has had a policy of building their new stores with skylights for a number of years. However, they also have a considerable number of stores built during the same period that do not have skylights. About 2/3 of the stores in the data set have skylights and 1/3 do not. Most of these non-skylit stores were acquired during mergers with other chains. The merged sites were then remodeled to match the design image and layout of the primary chain; however, skylights were not added. About ¼ of the non-skylit stores were originally built that way by the retailer itself. Apparently some new managers acquired during the merger did not agree with the skylighting policy, and so the new store sites where they had the greatest influence were built without skylights. Thus, there was not a systematic decision made about which sites should have skylights.

The retailer believes that they are seeing significant operational savings by turning off the electric lights under the skylights. However, we did not attempt to confirm these claims in any way. Our interest was in the impacts on sales.

The design and operation of all the stores in the chain is remarkably uniform. Other than the presence of skylights, the skylit stores have two other features that differentiate them from the non-skylit stores: higher ceilings and photosensor control of the lights under the skylights. No other systematic difference between skylit and non-skylit stores was observed.

The store design of the retailer in this study would best be described as an exemplary skylighting application. The skylights diffuse any sunlight so that there is even illumination below. The design provides high illumination levels during peak daylighting conditions, often two-to-three times the electric lighting levels. The electric lighting design throughout the stores is also carefully thought out in relation to the skylighting and is consistently applied. Most of the electric lighting is fluorescent, with strategic display lighting and highlighting used in both the skylit and non-skylit stores. Quality lighting design is very clearly considered part of the merchandising strategy for the chain.

A sampling of stores, both with and without skylights, found seemingly equal attention to other design elements such as building façade, signage presence on the street, and parking lot size and accessibility. All of the stores were laid out in nearly identical fashion, so that similar items were located in similar places. Stores of the same vintage had similar signage and decoration within the stores. The individual stores are managed at the corporate level, so management and advertising is extremely similar between sites.

Data from the Retailer

The retailer provided us with sales performance data for over 100 stores that included 2/3 with skylights and 1/3 without skylights. The monthly gross sales per store were averaged over an 18-month period running from February 1 of one year to August 31 of the next. Before it was given to us, this average was mathematically transformed into a “sales index” that was appropriate for statistical analysis, but that did not reveal actual dollar performance.

Stores in the sample were selected to operate within a limited geographic region that had similar climatic conditions, and to have constrained ranges of size and age. The geographic region has a relatively sunny climate. All of the stores in the data set are one story.

The retailer was also able to provide us with additional data about each store, which included:

- Square footage of store
- Hours of operation
- Location (zip code)
- Date of original construction
- Date of most recent major renovation
- Historical “type” of store, which influenced basic construction materials and architectural design.

Additional Data

In addition, we wanted to control for potential demographic effects of each store location. The retailer did not provide us with demographic information about the store locations, so we used census data tied to the zip code location of each store. To do this, we added two fields of data derived from the U.S. 1990 Census: population and average household income per zip code.

This demographic information is only a proxy for the influence of store location. We would have preferred a population density measure instead of raw population per zip code, but that information was not easily available. We do not know how representative the zip code location is of the population actually served by the store. The store could be located on the edge of a zip code boundary and more predominately serve other neighboring zip codes. We don't know how large each store's territory is. In some cases sales may be reduced by other members of the chain that are close by, reducing the effective population served by each store. We also don't know how many competing companies are within the territories for each store. Presumably some locations have more competition than others do.

A more sophisticated analysis would have also included a measure of the number of competitors within a given range, more information about the demographic characteristics of the population served by the store, and perhaps also information about a store's relation to various traffic corridors. Internal analysis might also have included information about the experience of individual store managers, or other measures of how well the sales staff might be expected to perform. However, this information was not available to us, and therefore we cannot account for the influence of these variables.

On-site Observations

We visited one dozen of the stores to confirm the information in the data set, and perform some on-site observations. On-site observations involved walking around the public areas of the store, observing and interviewing customers and staff. The focus of these site visits was to see if there was any other obvious influence on sales that we should explore further, or if there was any obvious correlation between skylighting and some other aspect of store configuration or operation that we should try to account for. We also used the site visits as an opportunity to probe how the skylights might potentially have an effect on sales.

Interviews

Informal interviews with shoppers repeatedly confirmed that the vast majority of shoppers were not aware of the skylights. The questioner, looking just like any other shopper, would approach a shopper and ask: "May I ask you a question?" The response was universally affirmative. We then asked, "What do you think of the skylights in this store?" The typical response was to look up, look puzzled, and then say, "That's funny. I never noticed them before." Out of 42 interviews in 10 skylit stores, only three shoppers could be found who were already aware of the skylights. Two of those volunteered that they had only noticed the skylights because their small child had pointed them out on an earlier trip, while looking up at a balloon or other bright object.

The questioner then asked: “Does this store feel any different to you than other stores like this?” By far the most common response (80%) was, “This store feels cleaner.” The second most common response (65%) was, “It feels more spacious, more open.” About one third of the respondents also mentioned that it was brighter. Three middle-aged respondents volunteered that they specifically came to this store instead of another closer to their home because they liked how it felt—cleaner, more open. Three elderly respondents commented on how important the brightness and the light quality were for them (although none had been aware of the skylights). Two middle-aged respondents talked about how important “natural” light was. Two older men commented that the energy savings must be considerable. Not one respondent objected to the skylights or had any negative comments about them.

Five store managers were interviewed about the skylights. All were positive about them, and reported they thought their customers liked them. Two mentioned the importance of energy savings. One commented on the “inviting feeling” the skylights created. Five store clerks were also interviewed: three were generally indifferent to the skylights; two were very positive, one saying, “I love them!”

3. FINDINGS

Using statistical analysis, it was determined that there were five main variables that had a significant effect on the gross sales per store. These variables are: the presence of skylighting, the number of hours the store is open per week, the population and income of the store's zip code, and the number of years since the store has last been remodeled. Next, the magnitude of the effect of these variables was determined.

The results of these statistical tests are graphed in Figure 3 below. This graph clearly shows the magnitude of the skylighting impact compared to the other significant variables. We discuss each variable in turn.

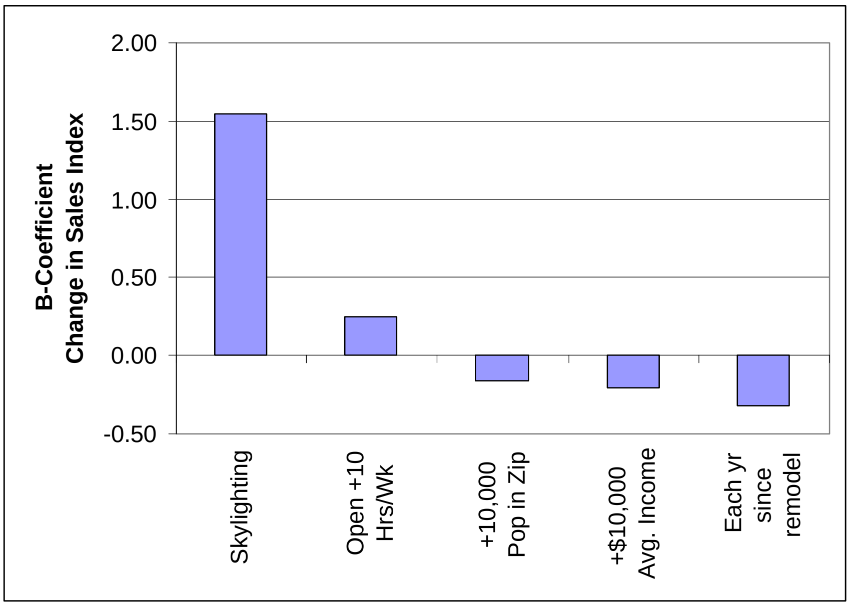

Figure 1: Change in Sales Index per Variable

Skylighting: A store with skylights is observed to have a sales index higher than an equivalent store without skylights. This is clearly the largest effect of any of the variables considered, (at B=+1.55). It is possible that there may be other reasons that the skylit stores are performing so well as a group. In our site visits, we made every effort to try to identify other characteristics of the skylit stores that might contribute to higher sales, but we did not find any obvious candidates. However, that possibility should always be kept in mind when examining these results.

Hours per Week: Opening more hours per week is seen to have a weak positive effect on store sales. Ten additional hours of operation per week shows a sales index increase of 0.2. The small effect here may be a function of the compressed range of hours possible for the stores in this chain, or the likely possibility that the optimum hours of operation for each store location has already been determined and implemented.

Population and Income: The negative effects shown here might seem to be counter intuitive. One might expect that having more people in the zip code where the store is located, and especially having a higher average income, would instead produce a positive effect on sales. However, the negative effect may occur since more densely populated and higher income areas may attract more competition, both from within the chain and from outside competitors. Indeed, on our site visits we noted that the stores in the chain did seem to be more closely spaced together in higher income areas. This was not confirmed in any formal fashion.

Years Since Remodel: The number of years since the last full remodel of the store is a highly significant variable. Each year since the last remodel shows a negative effect. A store, which was last remodeled five years ago, has lost about as many sale index points as a skylit store gains. Thus, according to this equation, if the chain remodeled all of its stores at least every five years, the effect would be of the same magnitude as adding skylights to all of the stores.

Figure 2 below presents the results of the regression equation in tabular form.

SIGNIFICANT VARIABLES:	B	Std. Error	t	Sig.	**Order of Entry**	**Change in R^2**
(Model Constant)	2.47	1.52	1.63	0.106		
Skylights	**1.55**	**0.36**	**4.35**	**0.000**	**5**	**0.04**
Hours open per week	0.02	0.01	2.65	0.009	1	0.16
Population (per 10,000)	-0.16	0.08	-1.99	0.049	9	0.02
Average income ($10,000s)	-0.20	0.10	-2.03	0.045	8	0.01
Years since last retrofit	-0.32	0.06	-5.12	0.000	3	0.09
Outlier 97	6.91	1.41	4.90	0.000	2	0.12
Outlier 57	4.98	1.44	3.47	0.001	7	0.05
Outlier 94	4.23	1.43	2.97	0.004	4	0.05
Outlier 15	5.82	1.57	3.70	0.000	6	0.04
					Model R^2	**0.58**
NON SIGNIFICANT VARIABLES:			Store types			
			Gross square feet			
			Years since original opening			

Figure 2: Retailer Regression Findings

The table shows that the skylighting variable has the strongest positive effect on sales of all variables considered. In addition, there is a 99.9% certainty that this is a true effect associated with skylighting.

4. DISCUSSION AND CONCLUSION

It is useful to try to translate the results of the model into terms that can be applied to other situations. In this analysis, we were not able to describe the absolute dollar value of the skylighting variable, therefore we will try to describe the relative effect of the presence of skylighting on sales in other ways.

Interpreting the Retailer Results

These results show that adding skylighting to the average non-skylit store within the chain would be likely to improve its performance by 40%, with a probable range somewhere between 31% and 49%. Thus, if this non-skylit store were averaging sales of $2/SF, then its sales might be expected to increase to between $2.61 and $2.98 with the addition of a skylighting system.

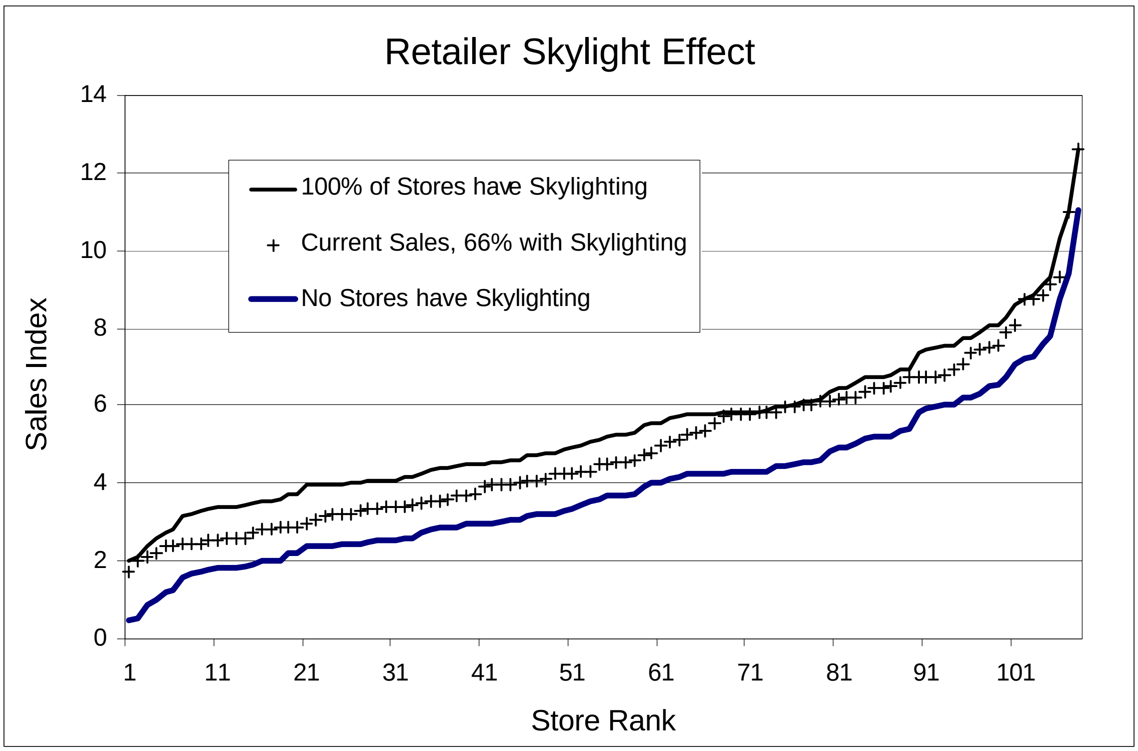

Figure 9: Chain-wide Sales Index with and without Skylighting

An alternative way to think about the impact of the skylighting is to ask how skylighting affects the overall gross sales for the chain as a whole. Currently 66% of the chain's stores have skylighting. If the chain added skylights to the rest of its locations, what effect would that have on gross sales? Figure 9 shows both the effect of adding skylighting to all stores in the chain, and the effect of removing the skylighting from all stores. The difference is dramatic. If this particular chain were to add skylighting to the remaining 34% of its stores, chain-wide sales could increase by up to11%. The difference between no skylighting in any of the stores, and skylighting in all of the stores, is a likely 40% increase in chain-wide gross sales.

It should be remembered that there were many other variables not considered in our analysis, such as the number of competitors within a store's territory. Also, in spite of the apparent uniformity of the stores, there may be operational differences between skylit and non-skylit stores that were not visible to the observer. For example, the air temperatures might be slightly different, or they may tend to use different music play lists that somehow affect sales. If such additional variables could be properly identified and found significant in the analysis, then magnitude of the skylighting effect would probably be reduced somewhat.

There is also no way to know how these results would translate to another retail chain. A different chain would have a different distribution of sales per store, which would change the percentage effect. It is, of course, also unknown how skylighting of a different design would affect a store with different operations. The results of the regression equation are specific only for this data set. However, while magnitudes may vary in other analyses, we can say that in this case there clearly seems to be a strong positive effect to skylighting, and it is quite significant.

Mechanisms

With this analysis, we have shown a clear relationship between skylighting and increased sales, and quantified the effect for this particular chain. The next question that arises is why does this happen? What is causing the increased sales?

Unfortunately, this kind of analysis cannot prove that skylighting causes increased sales. It can only demonstrate that there is a strong correlation between the presence of skylighting and increased sales. The reason for the effect is left to hypothesis at this point. Below we discuss a number of possible mechanisms for such an effect.

Customer Loyalty: In our interviews, it was clear that customers were not consciously aware of the skylights. But a number of them did express loyalty to a skylit store, because it seemed cleaner, or had better lighting. A few mentioned that they did routinely travel a little farther to shop at a skylit store over another option closer to their home. This informal survey suggests that there may a customer loyalty effect to skylights. This would translate into a competitive advantage in attracting and keeping more customers.

More Relaxed Customers: It may be that once a customer is in the store the skylights somehow relax them, in a manner similar to piped-in music, which has been found so effective at relaxing customers and encouraging them to spend more time in a store shopping. We do know from interviews that customers seem to have positive feelings about the skylit stores and identify those stores with an airy, clean feeling.

Better Visibility: The high illumination levels along with improved lighting quality from the daylight may make it easier or more comfortable for customers to select products. Especially for elderly customers with declining eyesight, labels are likely to be more legible during the peak daylight hours. It may be easier to find products and/or discriminate between alternatives with daylight illumination.

More Attractive Products: The skylights may make products seem more attractive, inducing customers to buy more expensive products, or simply more products, than they otherwise would. It is possible that the visual quality provided by daylighting, with high color rendition and three-dimensional modeling, may make products look more appealing.

Employee Morale: It could be that employees have higher morale, and as a result provide better service. We did not have any way to measure employee productivity. Ultimately, in a retail environment, employee productivity would be measured by sales per employee hour. Logically, if there are higher sales per store, and no increase in the staffing level, there will also be higher sales per employee hour.

Any one of these mechanisms, or all of them, may be responsible for the increased sales. In order to apply these findings to other retailers, and other organizations, it would be useful to understand which qualities of skylighting are the most influential. However, understanding the actual mechanisms may ultimately not be as important as determining the design characteristics of a high performing skylighting system. At this point in time, that information may best be obtained from a knowledgeable designer with substantial daylighting experience, rather than from a scientific study.

Applying the Results outside of Retail

Another important question to consider is whether these results translate outside of the retail sector. If skylighting is associated with higher sales, does that mean it might increase productivity in a manufacturing building, or improve morale in an office building, or reduce absenteeism at a postal facility? If so, by how much? The answer is, of course, that we don't know.

However, in a companion study, we have shown that daylighting is associated with higher test scores in elementary school students. Considered as a whole, the two studies suggest that there is a general principle at work whereby daylight affects human beings in a positive way. Furthermore, these studies indicate that when this effect can be quantified, the impact can be quite significant.

DAYLIGHTING *initiative*

Design tools and information from The Pacific Gas and Electric Company

Daylighting in Schools

An Investigation into the Relationship Between Daylighting and Human Performance

Detailed Report

August 20, 1999

Submitted to:
George Loisos
The Pacific Gas and Electric Company
on behalf of the
California Board for Energy Efficiency Third Party Program

Submitted by:

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1. EXECUTIVE SUMMARY

This study looks at the effect of daylighting on human performance. It includes a focus on skylighting as a way to isolate daylight as an illumination source, and separate illumination effects from other qualities associated with daylighting from windows. In this project, we established a statistically compelling connection between daylighting and student performance, and between skylighting and retail sales. This report focuses on the school analysis.

We obtained student performance data from three elementary school districts and looked for a correlation to the amount of daylight provided by each student's classroom environment. We used data from second through fifth grade students in elementary schools because there is extensive data available from highly standardized tests administered to these students, and because elementary school students are generally assigned to one teacher in one classroom for the school year. Thus, we reasoned that if the physical environment does indeed have an effect on student performance, we would be mostly likely to be able to establish such a correlation by looking at the performance of elementary school students.

We analyzed test score results for over 21,000 students from the three districts, located in Orange County, California, Seattle, Washington, and Fort Collins, Colorado. The data sets included information about student demographic characteristics and participation in special school programs. We reviewed architectural plans, aerial photographs and maintenance records and visited a sample of the schools in each district to classify the daylighting conditions in over 2000 classrooms. Each classroom was assigned a series of codes on a simple 0-5 scale indicating the size and tint of its windows, the presence and type of any skylighting, and the overall amount of daylight expected.

The study used multivariate linear regression analysis to control for other influences on student performance. Regressions were compared using data from two separate tests, math and reading, for each district. Each math and reading model was also run separately using first the window and skylight codes, and then the overall daylight code. We reasoned that if daylight effects were truly robust, the variables should perform similarly in all models. Thus, we created a total of twelve models for comparison, consisting of four models for each of three districts.

The daylighting conditions at the Capistrano school district were the most diverse, and the data from that district were also the most detailed. Thus Capistrano became our most precise model. In this district, we were able to study the change in student test scores over a school year. Controlling for all other influences, we found that students with the most daylighting in their classrooms progressed 20% faster on math tests and 26% on reading tests in one year than those with the least. Similarly, students in classrooms with the largest window areas were found to progress 15% faster in math and 23% faster in reading than those with the least. Students that had a well-designed skylight in their room, one that diffused the daylight throughout the room and which allowed teachers to control the amount of daylight entering the room, also improved 19-20% faster than those students without a skylight. We also identified another window-related effect, in that students in classrooms where windows could be opened were found to progress 7-8% faster than those with fixed windows. This occurred regardless of whether the classroom also had air conditioning. These effects were all observed with 99% statistical certainty.

The studies in Seattle and Fort Collins used the final scores on math and reading tests at the end of the school year, rather than the amount of change from the beginning of the year. In both of these districts we also found positive, and highly significant, effects for daylighting. Students in classrooms with the most daylighting were found to have 7% to 18% higher scores than those with the least.

The three districts have different curricula and teaching styles, different school building designs and very different climates. And yet the results of the studies show consistently positive and highly significant effects. This consistency persuasively argues that there is a valid and predictable effect of daylighting on student performance.

The results of this study of student performance, when considered along with those of the companion study showing the positive effect of skylighting on retail sales, also strongly supports the thesis that these performance benefits from daylighting can be translated to other building types and human activities.

2. INTRODUCTION

Is there an effect of daylighting on human performance?

The purpose of this study was to look for a clear relationship between human performance in buildings and the presence of daylight. This daylight could come from windows or skylights. We postulated that, by including buildings with skylights in the study, we could isolate the effect of pure daylight from all of the other ways that windows might influence human behavior.

Skylights provide a relatively simple illumination function, whereas windows may have a far more complex effect on people. Windows typically offer a view, which may provide relaxation, inspiration or distraction. They are often operable, which may add ventilation, air quality, and thermal comfort issues. Daylight illumination levels from windows are highly variable within a space, and may include aspects of unacceptable contrast and glare. User control of blinds or curtains also adds another variable that may be hard to define. Windows are connected with personal status, and may have psychological implications beyond their mere physical attributes. Skylights, especially diffusing skylights designed to provide uniform illumination, would not seem to be as imbued with cultural meaning and don’t tend to have as much variability in their function.

This report describes a study of how well elementary school students perform on standardized tests in relationship to the characteristics of their physical environment—specifically, how much daylighting is likely to exist in their classrooms. A companion study looks at the relationship between skylighting and retail sales. Both use a statistically rigorous methodology to isolate other potential influences, and report on the magnitude of an observed effect and its statistical certainty.

We chose to study elementary schools since children at that age spend most of their school time in one physical environment—their assigned classroom. Whereas students in middle schools and high schools tend to move from classroom to classroom throughout the day, in elementary schools children are usually assigned to one teacher in whose classroom they spend the majority of the school year. We reasoned that if the physical environment affects learning, it should be easier to identify any effects at the elementary level where we could characterize a given student’s environment with some certainty.

Since this is an interdisciplinary study, there are readers of many disciplines who have interest in its findings. We have attempted to satisfy the concerns of a wide range of readers, and so have perhaps included more detail than any one of these readers may find useful. We have also prepared a shorter, “condensed,” version of this report, which is available. In the discussion of the results at the end of the report, we also hypothesize why such an effect might occur. It is beyond the scope of this study to determine a causal mechanism, but we suggest pathways that might be considered in further research.

2.1 Background

The impact of daylighting on the performance of school children has been a subject of interest for many years. Before fluorescent lighting became prevalent, it was generally assumed that all school rooms would be daylit as a matter of course. The California Department of Education had a rigorous review process for the architectural design of classrooms to ensure that daylighting standards were met. As a result, California classrooms built in the 1950's and early 1960's remain excellent examples of daylighting practice. The "finger" plan with multiple rows of single classrooms, each with windows on two sides, became a standard for California K-12 campuses.

However, starting in the late 1960's a number of forces came into conflict with the daylit design of classrooms. Engineers, asked to provide air conditioning in classrooms, argued against the use of large expanses of glass and high ceilings. Construction economists argued that schools could be built more inexpensively on smaller sites if the classrooms could be built back to back or grouped together, without constraints on solar orientation. Facility managers often contended that windows and skylights were a maintenance and security risk. Educational theorists argued that a more flexible arrangement of classrooms, with open walls between them, would encourage team teaching and creative learning. Others worried that windows might just be a distraction for students. And specifically in California, educational planners, trying to meet the needs of an exploding school age population, required that at least one-third of all new classrooms be portable, so that, if the need arose, they could be moved to new areas with an overpopulation of new students.

As a result of these various pressures, the finger plan school was largely abandoned in California, and a vast experimentation in school design was undertaken. Many of the classrooms built since the 1960's have little daylighting. Windows are commonly built with "black glass" that allows a view out, but no useful daylight in. Numerous schools have been built with no windows at all.

Similar trends occurred nationally, and internationally, though perhaps without such a dramatic shift in design practice as in California. Concerned about the trend towards schools, and all types of buildings, without windows, Belinda Collins of the National Bureau of Standards conducted a major literature review on the study of windows in 1974[1]. At that time there was an ongoing debate about the desirability of windows in classrooms.

[1] Collins, B. "Windows and People: a Literature Survey, Psychological Reaction to Environments With and Without Windows", National Bureau of Standards, June 1975

In a compilation of studies on windowless classrooms in 1965, the editor, C.T. Larson, concluded that windowless classrooms should have no adverse effects upon their users. Larson stated, "The educational value of such a view [that windows are necessary for student learning] should be assessed against the cost of installing and maintaining classroom windows.[1]"

Collins also quotes from a book on the behavioral aspects of design, which also concluded that windows were not needed in classrooms. "At present the pro-window forces still lack behavioral data in support of their case and argue on the basis of metaphor and supposition, but their arguments must be weighed against statistics…from the windowless schools…reported to have 40 percent greater efficiency in heating and cooling, constant light to prevent eye strain…35 decibels or more noise reduction, and reduced maintenance costs." The author went on to claim that the use of completely underground schools provided evidence that claustrophobic reactions were extremely rare. He stated further that, "Opponents [of windowless schools] now take recourse in the need for communion with nature, contact with the outside and stimulus variation, which are more difficult to measure, and whose importance is not readily apparent."

Collins herself found that the research that had been done as of 1974 was suggestive of the importance of windows, but inconclusive:

> *"Much, though not all, of the evidence from the windowless classroom studies is inconclusive, or inadequate, while that from windowless factories is circumstantial, based on hearsay, rather than research. As a result, only tentative conclusions can be drawn about the qualities of windowless spaces that make them somewhat less than desirable."*

Since Collins' study, other research on the importance of windows has been done, but primarily in hospitals. The most rigorous studies have been conducted in Europe. One interesting study in Sweden in 1992 looked at the impact of daylight on the behavior of elementary school children.

The Swedish researchers followed the health, behavior, and hormone levels of 88 eight year old students in four classrooms over the course of one year. The four classrooms had very different daylight and electric light conditions: two had daylight, two had none; two had warm white (3000K) fluorescent lamps, two had very cool (5500K) fluorescent lamps. The researchers found significant correlation between patterns of daylight levels, hormone levels, and student behavior, and concluded that windowless classrooms should be avoided[2].

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[1] Larson, C.T. (ed), *The Effect of Windowless Classrooms on Elementary School Children*, The Architectural Research Laboratory, Department of Architecture, University of Michigan, 1965.

[2] Kuller, R and Lindsten, C "Health and Behavior of Children in Classrooms with and without Windows", Journal of Environmental Psychology, (1992) 12, 305-317. Further discussed in Section 5.1.4.

Recent, more informal studies in the United States suggesting a relationship between daylighting and enhanced student performance have generated considerable excitement among daylighting advocates.[1] These studies, along with a rising interest in “natural” and “healthy” environments, have contributed to a resurgent interest in daylighting in schools. All three districts that we worked with in this study reported that daylighting in classrooms is currently a concern for their school boards, driven largely by parent activism. However, without credible evidence of relationship between the design of schools and the performance of students within them, classroom design issues remain subject to architectural and educational fads, just as in the past. We hope that this study provides a contribution towards more durable understanding of how the physical environment affects student performance.

[1] Nickas, M. and Bailey, G., “Analysis of the Performance of Students in Daylit Schools,” Proceedings of the American Solar Energy Society 1997. The study reports positive results for children moving to daylit schools in North Carolina. The analysis, however, based on a small sample, cannot provide any certainty that this was not a random effect.

3. METHODOLOGY

Our study methodology compared the performance of people in similar buildings with a range of daylighting conditions. To do this, we sought organizations that had pre-existing productivity measurements that could be compared between buildings with and without skylights, or with a scalable range in daylight conditions. We began by casting a wide net looking for the ideal organizations that could provide us with data sets amenable to our analysis.

3.1 Data Set Criteria

Our criteria for selection included organizations which:

- Operated at least 60 sites, about ½ with and ½ without skylighting, or which had a scalable range of daylighting conditions
- Where all building sites had nearly identical operations, and similar climate conditions
- Where human performance measures, that could be identified by building site, were consistently tracked in an electronic database
- And, of course, where the organization was interested in participating in the study.

The human performance data could then be statistically analyzed to see if there was a significant correlation between the presence of daylighting and improved performance. We would attempt to control for as many other variables as possible using multivariate regression analysis. We realized that our ability to control for other influences on human performance or for random error would be limited by:

- The size of the data set
- The availability of information about other influences
- The time period of the performance measurements

Thus, our goal was to find data sets as large as possible that measured human performance over a long time period, and that allowed us the opportunity to control for other potential influences on performance.

3.2 Selection of Sites

We began our search for data sets by identifying target-building types, and then conducted an extensive phone search to identify organizations that might meet the criteria above. We focused on:

- Chain store retailers
- Manufacturers with multiple locations, or the potential for “before and after” measurements
- Distributors with multiple locations
- Elementary school districts
- Office buildings with identical operations at multiple sites

After identifying potential sites all over the country, we began a multi-level screening process. We interviewed potential candidates and attempted to negotiate cooperation agreements with the best candidates. For the commercial sites, confidentiality and interference in operations were significant concerns. A promising manufacturer with excellent data on employee productivity was eliminated as a study participant when the upper management ruled the study to be an unnecessary distraction to production.

After over 125 interviews with candidate organizations, we settled on four participants who best met our criteria:

- A chain store retailer
- Three elementary school districts

This report details the analysis and findings from the school district data. A companion report details the work with the retail data.

3.3 The School Data Sets

We chose to work with elementary school districts, and not high schools or other age groups, for a number of compelling reasons:

1. Elementary school children tend to spend the majority of their school time in one classroom with one teacher.
2. Elementary students tend to follow a highly standardized curriculum, so that individual student achievement tests can be compared across schools, and even across districts.
3. Elementary schools tend to have fairly uniform classroom design, with a standard size and shape.

The three school districts selected were

- Capistrano Unified School District in Southern California
- Poudre School District in Fort Collins, Colorado
- Seattle City Public Schools in Washington State

Each district has some schools with skylights and/or roof monitors, as well as schools without. The size of the districts ranged from 23 to 61 elementary schools.

We believed that the geographic diversity of the three districts would allow us to test for the effects of daylight across differences in climate, curriculum, administration, school design, and student testing protocols. By working with three districts, we also increased our chances of finding at least one data set that was sufficiently robust for detailed analysis.

The school districts agreed to provide us with one or two years of student scores on both math and reading standardized tests for all their children in grades 2 through 5. In addition, they provided associated demographic data that they collected about the students. To ensure confidentiality, all information that could potentially be used to identify an individual was removed from the data sets.

To confirm the impact of daylighting in these schools, we planned to check for consistency of results by running the analysis for a total of twelve cases:

- The three school districts
- The two tests (math and reading)
- Two alternate sets of daylight variables (“daylighting,” and “skylights plus windows”).

We reasoned that if we could find a consistent pattern among the results of these twelve distinct models, then we would have more robust findings.

Two sets of data were assembled for each school district. The first database contains the student records that we received from the district itself. The second database for each district contains the school/classroom characterizations of window lighting, skylighting, and daylighting.

3.3.1 Student Data

The districts provided us with large data sets of a number of different student test scores and student demographic characteristics for a two year period. In order to achieve consistency between districts we choose to use just the math and reading test scores in our analysis. We also endeavored to keep the demographic variables consistent between districts.

Types of Standardized Tests

We used two types of standardized student tests in our analysis. Seattle provided us with the Iowa Test of Basic Skills (ITBS), Form M, a national test. The raw test scores were formatted using a Natural Curve Equivalent (NCE) scale derived from national norms, which identifies equal increments in response, such that results at different ends of the scale can be correctly compared on an arithmetic scale. Thus, with an NCE scale, an improvement of 5 points has the same meaning whether it's at the high or low end of the scale. This allowed us to make meaningful judgments about how much of an effect a variable might have across the spectrum of possible scores.

Capistrano and Fort Collins provided us with "level tests" developed by the Northwest Evaluation Association (NWEA), specifically tailored to the districts' curricula. Since these tests do not have nationalized norms, they use the Rausch Unit (RIT) scale to create an equal interval scale that is similar to a NCE, but not calibrated to national norms. The RIT scale is calibrated across all (grade) levels of the tests, so that a growth of ten units is equivalent at any point in the scale or level.

The Capistrano tests were administered to all elementary school children in both the fall and spring of each year. This gave us the important opportunity to compare individual student progress within one school year. The Fort Collins tests were also administered in both spring and fall, but were optional for many students in the fall. As a result, it was not possible to compare student performance consistently between the two time periods across the whole data set.

Figure 1 below summarizes the source of the standardized tests used in our analysis, and the test format.

	ITBS (NCE scale)	NWEA Level Tests (RIT scale)	Absolute Scores Spring '98	Change in Scores Spr '98-Fall '97
Capistrano		X		X
Seattle	X		X	
Fort Collins		X	X	

Figure 1: Test Types for Three Districts

Demographic Information

Each district provided extensive information about the demographic characteristics of the students in the data sets so that we could control for these well-known influences on student performance. We attempted to assemble data sets which had demographic descriptors that were as similar as possible.

Student identification was masked by a false student record number for all data sets. In addition, some districts decided to provide some demographic data at a classroom level to further mask individual student records. Thus in Capistrano, we were provided with the percentage of students per classroom with free or reduced lunch, rather than a code per each student record. Similarly, in Seattle, information about participation in the gifted program was provided at a classroom, rather than a student level.

We have re-named the demographic variables in this report to make them generic, and avoid unnecessary focus on issues outside the scope of this study.

For example, we report on Ethnic 1, 2 and 3, rather than the ethnic indicators we were provided with. Similarly, in our reporting, we have scrambled the identification numbers for school sites, and any other identifying information.

3.3.2 Classroom Characteristics Data

A second data set, describing the physical characteristics for each classroom in the three districts, was created. When possible, we began by examining existing databases about the schools. This information was then verified and augmented by reviewing architectural plans and aerial photographs for all of the schools. Principals and maintenance personnel were also interviewed to confirm details about the windows and skylights. In addition, we conducted on-site surveys of most of the "types" of schools to confirm the information: we took photographs and daylight measurements, observed operations and interviewed a few teachers.

Size and Types of Classrooms

From the existing data sets, and especially from the architectural plans, we could usually identify;

- The original construction date of the school
- The size of the school (in square feet)
- The size of the classroom (in square feet)
- The type of the classroom—open, cluster or pod, portable, traditional
- The presence, size and geometry of windows and skylights.

Daylight, Window and Skylight Codes

Our initial intent was to isolate the effect of daylight through the study of skylighting. However, in this schools study we were unable to do so because of the prevalence of windows. The effect of skylights was inevitably mixed with the effect of windows. To resolve this, we collected data on both windows and skylights so that we could analyze them either separately or as a combined effect.

Whenever possible, the information collected included the dimensions of glazing, the transmissivity of the glazing, any fixed shading or obstructions, and the expected distribution of the light given the geometry of the glazing. It did not include window orientation, operable shading, or movable obstructions for windows. The effort was directed at creating a rough prediction of potential daylight illumination levels and distribution, but not of glare and other lighting quality parameters.

Ideally, a daylight variable would be based on observations of daylight illumination conditions throughout the school year. Many things change during the school year relative to daylighting. Curtains open and close. Pictures get posted on windows, then taken down. Trees loose their leaves, then leaf out again. Sun angles change, reflecting off of sidewalks, or not. Weather conditions change. Unable to account for all these temporal variations, we tried to create a relatively stable metric that described the "opportunity" for daylight over the course of the school year. Given the limited information we were working from, and especially the vast number of classrooms that we had to categorize (over 2000 in the three districts), we did not try to achieve any higher level of accuracy than a 0 to 5 scale.

We relied on the experience of the three daylighting experts involved in this study to apply the following qualitative guide to each classroom:

5 Best daylighting. Classroom is adequately lit with daylighting for most of the school year. Adequate daylight available throughout classroom.

4 Good daylighting. Classroom has major daylight component, and could occasionally be operated without any electric lights. Noticeable gradient in illumination levels.

3 Average condition. Classroom has acceptable daylight levels directly next to windows or under skylights. Strong illumination gradient. Some electric lights could occasionally be turned off.

2 Poor daylighting. Illumination is always inadequate without electric lights. Glare a likely problem.

1 Minimal daylighting. Small, token windows or toplighting.

0 Classroom has no windows or toplighting.

The window and skylight codes were assigned independent of each other, ranking the various options available in the districts, from none to best. The daylight codes, on the other hand, were assigned considering the combined effect of windows and skylights together. For example, if a skylight (code 2) in the back of a room balanced the light from windows on one wall (3), then the classroom was given a daylight code (4): higher than either the window or skylight codes for that room. Alternatively, if a room already had full daylighting from aggressive skylighting (5), then the presence of some windows (3) would not raise the daylight code (5).

In practice, the codes were assigned slightly differently for the different districts, based on the types of conditions encountered, and on our level of information. The following two charts summarize how the codes were applied in each district.

The average daylight footcandle (fc) expectations listed below were used as a rough guide for the rater. They were not verified with on-site measurements since we could not visit enough classrooms under similar daylighting conditions.

Window Ranking Scale					
Quality description **CODE**	Daylight distribution likely fc room avg	**SEATTLE**	**CAPISTRANO**	**FT COLLINS**
Best **5**	even 50+fc	Window wall on two sides of room, high ceilings Clear glass, no sun penetration	Same as Seattle 150+ sf windows	Did not occur
Good **4**	acceptable 30+fc	Shallow classroom with window wall on one side #5 with medium tint and/or obstructions	Same as Seattle 100+ sf windows	Did not occur
Adequate **3**	dark areas 15+fc	Deep classroom with window wall on short side #4 with medium tint and/or obstructions #5 with dark tint and/or major obstructions	Same as Seattle 60+ sf windows	8-13% WFR clear glass
Poor **2**	glare from windows 5-10 fc	Windows on one side, 20% - 50% of wall length. #3 with tint and/or obstructions	Windows 30 sf- 50 sf, no tint Windows 40 sf - 60 sf medium tint Windows 60 sf - 80 sf dark tint	3-4% WFR medium tint
Minimal **1**	very local 1-5 fc	Windows < 20% of wall length Heavily obstructed windows	Windows 40 sf or less, medium or dark tint Example: most portables	1-2% WFR medium tint
None **0**	none 0 fc	No windows	No windows	No windows
District specific notes:		Window percentages are of wall length, not area	960-1050 sf typcial classrooms	WFR = Average classroom window to floor area ratio

Figure 2: Window Codes as Applied

Skylight Ranking Scale				
Quality description **CODE**	Daylight distribution likely fc room avg	**SEATTLE**	**CAPISTRANO**	**FT COLLINS**
Best **5**	even 50+fc	Very large skylight > 20% of floor area Fixed louvers	Central skylight, 6' x 6' pyramid diffuser Operable louvers	South facing monitor, diffusing glass Operable shades
Good **4**	acceptable 30+fc	Large skylight area >12% of floor area Black out blinds	Clear 6' x 6' skylight, corner of room Same as #5, deeper well	Did not occur
Adequate **3**	dark areas 15+fc	Medium skylight area 4-10% of floor area Black out blinds	Central skylight, flat diffuser 6' x 6', low transmission Operable louvers	Did not occur
Poor **2**	local 5-10 fc	Small skylight area 2-4% of floor area Interior room with small clerestory area	Medium tint 2' x 8' monitor, at back wall	Did not occur
Minimal **1**	very local 1-5 fc	Interior room with minimal access to clerestory	Did not occur	Spill from monitor in adjacent hallway
None **0**	none 0 fc	No toplighting	No toplighting	No toplighting

Figure 3: Skylight Codes as Applied

On-Site Observations

Site visits were performed twice for each school district. The first round of site visits confirmed the presence of skylights and scoped out the range of conditions that should be accounted for in our classroom data sets. As part of this exercise, we took sample light level readings in Capistrano and Seattle to help us categorize the types of toplighting and the range of window conditions. Sample illumination readings for each district are included in the appendix.

A second round of site visits took place after the preliminary analysis and before the final analysis, to confirm the categories used in the data sets, to verify conditions, and to investigate operating conditions at the schools. All in all, the greatest attention was paid to verifying information from the Capistrano schools, which became our primary analysis site. With over 60 schools in the Seattle district, we focused our attention on those schools with toplighting or exceptional conditions. The least attention was paid to Fort Collins schools, which had the most uniform conditions, and also turned out to be our weakest data set.

Between both rounds, we visited sites representing over 90% of the Capistrano schools, 25% of the Seattle schools, and 30% of the Fort Collins schools.

3.3.3 Data Assembly

Microsoft Access was used to join all the student record data sets and the building characteristic data. Data spanning the 96/97 and 97/98 school years were received from all districts. In the case of Capistrano, the data arrived in 16 separate tables. The districts provided similar, but not identical information.

All information that might have allowed identification of an individual was stripped from the data set. Any identification numbers for students or school sites contained in this report have been transformed, and are not actual values.

The information that we eventually had available to consider for each district is detailed below:

Physical Conditions:	Capo	Seattle	Ft Collins
Daylight Code: 0-5,	X	X	X
Window Code: 0-5	X	X	X
Skylight Code: 0-5	X	X	X
and/or Skylight Types: (A, AA, B, C, D)	X	X	
Air Conditioning: yes/no,	X		
AC types: original, retrofit, wall mount, none	X		
Operable Windows: yes/no	X		
Classroom type: traditional, portable, semi-open, modular	X	X	X
School Operation:			
School Site ID:	X	X	X
Language Program: yes/no	X		
Year Round Schedule: yes/no	X		
Students per School: count	X	X	X
Students per Classroom: count	X	X	
Age of School: yrs since original construction	X	X	X
Student Characteristics:			
Grade level	X	X	X
Classroom assignment	X	X	
Ethnicity	X	X	X
Special Education program	X	X	X
Non-English speaking		X	X
GATE identified: Student level	X		
Gifted classroom: 70%+ gifted		X	
Lunch Program: student level		X	X
Lunch Program: % in classroom	X		
Living w/ mother, father, other?		X	X
Gender	X	X	X
Absences Unverified: count per student	X		
Absences Unexcused: count per student	X		
Number of Tardies: count per student	X		

Figure 4: List of Descriptive Data Fields for Each District

3.3.4 Data Cleaning

A substantial effort was expended in cleaning the data sets and matching the student records to classroom locations. We received data from every student in the district, but were only interested in those students taking standardized tests while participating in a standardized curriculum, while spending a majority of their time in one "homeroom." Thus, we set criteria to include only second through fifth grade students being taught under the "normal" district conditions. We made these judgements based on conversations with the personnel from each district involved in testing and curriculum.

Criteria that we used for elimination from the data set were:

- Grade assignment K-1 or 6+
- Missing test scores
- Missing classroom identification (except in Fort Collins)
- Special education code
- Non-English speaking
- Attendance at a specialized academy (non-standard curriculum)
- Participant in home schooling program
- Codes outside of proper range or format

We choose to include the gifted and talented (GATE) identified students in Capistrano and Seattle because they were taught in the regular curriculum, often with before or after school enrichment programs. They spend most of their time in the same classroom with the regular students, and they are following the same curriculum path. (We were not given a GATE identifier for Fort Collins.) Special education identified students, on the other hand, have a wide variety of codes—visually handicapped, physically handicapped, learning disabled, behavior problems—with all kinds of pull-out programs, special tutors, and different curriculum tracks. Sometimes, they spend only one to two hours in their assigned "mainstream" homeroom. Also, the special codes and classifications used by the three school districts varied considerably. Rather than trying to sort out codes between districts, and trying to figure out which students spent a majority of their time in the classroom on the main curriculum, and which were in pull-out programs, we decided to just eliminate all special education codes across the board.

In addition, we encountered a considerable challenge matching students to classrooms. The Capistrano data set linked students to teachers, but not to classrooms. Thus, we had to create a map from teacher to classroom location for each school. This was possible for a majority of the 97-98 data, but much more difficult for the 96-97 data, as many records were lost. Ultimately, we dropped the hope of using the 96-97 data because too many schools no longer had records.

Comparing Across Years

We were provided with test scores for spring and fall for both the 97-98 and 96-97 school years. We hoped this would give us the opportunity to compare the progress of students from fall to spring and/or from year to year. The year to year comparison was discarded, however, as we found it impossible to map sufficient numbers of children from their teacher to their physical classroom location for the earlier period.

A year to year comparison presented two other challenges. First of all, 25% of the population was automatically lost when comparing between the years, since only 3 of the 4 grades could be compared between years. Secondly, and most important, we realized that there were significant differences in overall performance between the grade level tests. The grade level of students was consistently one of the most important explanatory variables in our regression models. Thus, comparing performance of an individual between successive grades was probably not valid.

The final analysis therefore uses only data from the 97-98 school year.

3.3.5 Size of Final Data Sets

The size of the final data sets was a function of how many student records could be matched to a specific classroom, had no missing fields for other descriptive information, and met all other criteria for inclusion. The largest group of records was removed from the final data sets simply because they were outside of the grade 2-5 range (some of the original data sets included children from K-8). Thus, in general the number of students was immediately reduced by 4/6ths or 4/7ths, or four grade levels out of six or seven. A few entire schools were removed because they were closed for all or part of the 97-98 year, or because they operated special academies outside of the normal curriculum.

	Original			Final		
	Records	Schools	Classrooms	Records	Schools	Classrooms
Capistrano	13,913	27	752	8,166	24	389
Seattle	16,384	61	1093	7,491	57	537
Fort Collins	8,408	23	NA	5,687	21	NA*

Figure 5: Size of Final Data Sets

*Fort Collins schools typically have about 18-24 classrooms per school, but the data was analyzed on a school level basis.

3.4 Regression Analysis

The data was entered into the statistical analysis software program, SPSS, to run multivariate linear regression models. The regression model calculates a "B" coefficient and a standard error for each variable included in the model. The standard error for each independent variable is used to calculate a number of statistical tests to predict the certainty of the observed effect.

The B-coefficient is the magnitude of the effect on the dependent variable of a one-unit change in the respective independent variable. If the variable is yes/no, then the B-coefficient is the full extent of the effect. For example, an assignment of a student to a language program is a yes/no variable. Thus a B-coefficient of +2.19 for a language program variable is interpreted to mean that, on average, students in the language program receive +2.19 higher points (± the standard error) on the standardized test which is being considered as the dependent variable.

If the variable has a range of units, such as the 0-5 window variable, then the B-coefficient is the effect of a one unit change in the 0-5 scale. For the full range of the potential effect, for example from no windows in classrooms (window code = 0) to maximum windows (window code = 5), one would multiply the B-coefficient times the range of the scale; in this example, by a factor of five.

The most important difference in the regression models for the three districts is the dependent variable. The Capistrano model used the change in math and reading student level-test scores from fall 1997 to spring 1998 as the dependent variables. The Seattle and Fort Collins models used only the actual value of the spring 1998 tests.

A number of preliminary runs were conducted to understand the behavior and influence of the variables. Four models were run simultaneously for each set of primary daylighting variables considered:

1. **Reading Daylight**: dependent variable = reading scores,
   run with the daylight variable

2. **Reading Skylight**: dependent variable = reading scores,
   run with the window and skylight variables

3. **Math Daylight**: dependent variable = math scores,
   run with the daylight variable

4. **Math Skylight**: dependent variable = math scores,
   run with the window and skylight variables

It was assumed that in a robust model, all of the significant variables would perform similarly in all four models. Thus, if a variable, whether a primary daylighting variable or one of the many control variables listed earlier, showed up positive in one of the models and negative in another, we looked further for problems in the data and/or co-linearity with other variables.

3.4.1 Refinement of Models

After all the variables of interest for a particular run were entered into the model, the residuals were calculated for each student record. The residual for a record is the actual value of the dependent variable for that record, minus the value predicted by the regression equation. The student records with the greatest absolute value for their residuals were considered to be the outliers. Once an outlier was identified, an indicator for the student record was entered into the model in order to control for the influence of the outlier on the model. A judgement was made by the analyst on the number of outliers to be entered into the model, according to the distribution of the residuals for each model.

The full regression equation was then run again in SPSS, this time including the newly identified outlier indicator variables. The same process was performed to identify any additional outliers that may have become more influential due to the addition of the first set of outliers. After several such runs of the full model, with new outliers being added during each run, a model was settled on that identified all the extreme cases.

The next step in the process was to use the backward elimination method to select the subset of independent variables that were most significant in the models. The backward elimination method removes the least significant predictor at each step. A non-daylighting variable was dropped if its statistical significance was less than 0.10 (90% certainty of an effect). A daylighting variable had to achieve a higher significance of 0.05 for inclusion in the model (95% statistical certainty). We used a lower standard of significance for the non-daylighting variables as a conservative method to include all potential influences which might reduce the impact of the daylighting variables.

Once the most significant subset of variables was identified, those variables were entered into the regression. The residuals were inspected again to ensure that there were no additional outliers in the model. If outliers were identified, then the model was run again with the corresponding indicator variable included. This iterative process was used to develop each preliminary model and the final model described in this report.

As the last step in the analysis, a step-wise regression was performed to determine the explanatory power of each variable included in the final models. The step-wise regression calculated the R^2 for each additional variable added to the model, in order of influence. This is termed the “explanatory power” of each independent variable, as it is a function of both the magnitude and the certainty of the observed effect. The R^2 for each variable reflects its ability to effectively explain the variation of the data found in the data set. The most powerful explanatory variables enter the step-size regression first, and the least powerful, but still significant, enter last. (See the Appendix for charts which show the order of entry, and the change in R-squared, for all variables included in the final models.)

4. ANALYSIS AND FINDINGS

In this section we report on the findings for each of the three school districts in turn. First we describe the relevant characteristics of each district, so that the reader can understand the context and better evaluate the results. Then we discuss the analysis process, and any peculiarities for the analysis of that district. Finally, we report on the specific model results for each district.

The greatest attention is given to the Capistrano analysis, since it is the most detailed model and, we believe, has the most interesting findings. With the Capistrano data we were successful in creating a model based on the change in test scores between the fall of 1997 and spring of 1998. Thus, this model, which we refer to as the “delta” model, reflects the change that occurred in students’ understanding of the class material during the school year that they occupied a given physical environment. It also uses each student as his or her own control. As a result, all of the demographic variables drop out, and we are left with a simple model containing only those few variables that are seen to directly influence the rate of student improvement.

For the other two districts we had to use the actual test scores from one time period rather than the change in score between two time periods. These models, which we refer to as the “static” models, report on a snapshot of student performance at one point in time. There is an assumption that the most recent classroom experience will influence how students perform on tests administered in the spring at the end of the school year. However, the absolute level of student performance is a function of many influences, including where each student started at the beginning of the year. Thus, in these static models, the demographic and socio-economic variables become important predictors of absolute student performance, and add many more variables to the final equation[1].

4.1 Capistrano Characteristics

The Capistrano School Unified District provided us with data on 27 elementary schools, of which nine included skylights in their classrooms. The Capistrano District was by far the most complex data set that we analyzed. We had the most information about its diversity in student population, administrative structure, and

[1] Including a previous year’s test score could also help to control for initial differences at the start of the year. While this method could help control for initial differences, but could also create serious co-linearity problems in the model, making it more difficult to interpret. We were limited by incomplete data for previous years, and so choose not to explore this approach.

physical conditions. It presented both the greatest challenges and the greatest opportunities for study.

4.1.1 Demographic Characteristics

The Capistrano Unified School District serves a population of more that 40,000 students in 44 schools from kindergarten through high school. It covers an area of more than 195 square miles and includes 10 small cities in Orange County in California. It runs inland 25 miles from the Pacific coast.

The district tends to have a wealthy population, although there are pockets of lower income and immigrant families. The older neighborhoods nearest the coast tend to have the highest average household income. However, new developments farther inland are also very upscale. The district population is 75% white, 17% Hispanic, 5% Asian, 2% African American and 1% other minorities.

4.1.2 District Curriculum

The district maintains great uniformity in its basic elementary curriculum and testing procedures (one of our basic selection criteria). However, they do allow each school to operate special magnet programs or establish special “flavors” for their schools. Children are allowed to attend any school in the district, but their parents must provide transportation. Many special programs attract children to schools outside of their neighborhood. The variety of elementary programs include:

- Three year-round schools (with varying schedules)
- Three bi-lingual immersion programs (two Spanish, one Japanese)
- Environmental education
- Arts centered education
- Gifted and Talented cluster classrooms
- Extensive parent participation

The district has a gifted and talented program (GATE) which operates within each school. GATE identified children are clustered into classrooms so that there are no fewer than eight GATE children in one classroom, to ensure that they have a functional peer group. Each school is responsible for creating its own GATE program, but most include enrichment activities before or after school for the GATE children.

The district also operates many special education programs. Most special education students are mainstreamed into regular classrooms, with additional support provided outside of the classroom. Some children, especially those with extreme physical disabilities, attend a school with special facilities for their treatment. Non-disabled children also attend classes at these schools.

4.1.3 School Characteristics

The physical plant of the Capistrano Unified School district is similar in many ways to other California school districts. They have a set of schools which date from the 1950's through the 1990's, with substantially more built in later years. (Schools built before the 1950's have generally been converted to other uses due to lack of earthquake safety.) The schools are all single story, and almost all classrooms have a door directly to the outdoors. The district has a number of "pairs" and "families" of school types that were built by the same architect from similar plans. (See Appendix for photographs of schools and classrooms.) The district has a number of schools which represent plan types popular in each decade:

- **Finger schools** from the 50's and 60's with ample daylighting from window on two sides of the classrooms, grassy planted areas in between the wings, and careful attention to orientation and sun angles.
- **Wing schools**, from the late 60's and early 70's with wings of back-to-back classrooms each with a single window wall, usually with very low transmission ("black") glass. Plans generally show little attention to orientation and sun angles.
- **Open plan schools** from the 70s, with few, if any, windows into the classroom "pods." Classroom areas were designed to flow into one another, often with a shared central resource area. Partitions have since been added to all of the original open plan schools, so that there is some visual privacy, but rarely acoustic privacy, between classrooms. Due to recent class size reduction mandates in California, these open plan schools have often been subdivided into even smaller classroom areas than originally anticipated, creating a maze-like atmosphere.
- **Modular plan schools** from the 80s, typically in wings, but often with clustered classrooms divided by movable partitions and shared work rooms. Built with pre-fabricated elements.
- **Most recent schools** in the 90's have a variety of plan types, some wing schools, some with interior hallways and common workrooms.
- **Portable** or "re-locatable" classrooms. California schools have been required to install portable classrooms to address the needs of a rapidly changing population. These classrooms are similar to mobile homes: they are factory built, shipped to the site, and installed above grade. They are typically 24' x 40' with a door and 3' x 6' window at one narrow end, and a smaller window and HVAC unit at the other narrow end. Perhaps 10% of the portables are 30' x 30' versions, but with similar window areas. There are a handful of 18' or 12' x 40' classrooms. These portables exist at every school site in the district, and constituted 40% of all classrooms in our data set. Because every school site

had at least a handful of portables, and because of their uniformity across schools, the portables served as something of a “placebo” in our analysis.

The size of classrooms and schools was not considered in the Capistrano analysis since in California the size of an elementary classroom is highly standardized at 960-1000 SF. There has been a recent phenomenon of creating smaller classrooms for grades 1-3 due to requirements for class size reduction. Formulas, based on average daily student attendance, have been used to determine the maximum square footage allotment for classrooms in school districts that compete for state funding. As a result, the square footage of schools is a direct function of the number of students attending. Thus, the only size variable we considered at Capistrano was the number of students per classroom and the number of students per school.

As described above, the district has a wide range of window conditions, depending on the plan type. In addition to these common school plan types, Capistrano had a rather unique feature, in that many of the later school plans included skylights in the classrooms. In the late 70’s, after having built a number of open plan schools with no windows at all, the school board became concerned that natural daylight was essential for a healthy and positive classroom setting, and so directed all architects hired to design new campuses to provide natural lighting in the classrooms, including both windows and skylights. As a result, the district now has nine elementary campuses that include skylights in the classrooms.

Daylight Code	Number of Students	Window Code	Number of Students	Skylight Type	Number of Students
0	942	0	942	A SKYLIT	492
1	1435	1	5317	AA SKYLIT	279
2	3849	2	932	B SKYLIT	350
3	953	3	420	C SKYLIT	336
3.5	139	3.5	139	D SKYLIT	106
4	390	4	184	No Skylight	6705
4.5	120	4.5	120		
5	440	5	214		
Grand Total	8268	Grand Total	8268	Grand Total	8268

Figure 6: Daylight Codes for Capistrano District

Figure 6 shows the distribution of final daylight codes assigned for the Capistrano district, including the readjustments described on page 32. The very large number for Window Code 1 is largely due to all the portables in the district, which constitute about 40% of the classrooms in our data set. The large number of Skylight Code 0 describes the relative rarity of skylights.

Skylight Types

There are five types of skylights that have been employed under various plans:

Skylight Type A has an acrylic bubble skylight on the roof and an inverted prismatic pyramid diffuser set in a splayed ceiling well in the center of the classroom. It also includes a manually operated internal louver to control illumination levels. This 6'x6' skylight design provides high levels of diffuse illumination (50 to 250 footcandles measured on a sunny day) distributed to the entire floor area of the classroom, but little to the walls. This skylight type was initially assigned a code of 3, 4 or 5 depending on variations in skylight transmittance and well depth that affected the levels of illuminance achieved in the classrooms. (The final analysis uses just the Skylight type, not the code number.)

Skylight Type AA is similar to Type A, but uses a flat diffuser (made of “twinwall”) set in the plane of the ceiling. There were fewer of this type of skylight, and they only occurred in older modular classrooms. They were initially assigned a code of 3.

Skylight Type B is a clear 6'x6' skylight with no louver controls. It is set at one corner of the classroom, generally over the teacher’s desk. It frequently allows sun to splash directly on the classroom walls or floor. Horizontal illumination on a sunny day ranged from 15 to 100 footcandles. Vertical daylight illumination on the classroom walls was typically higher (15 fc vs. 5 fc) than in the types A and AA. They were initially assigned a code of 4.

Skylight Type C is a clear 6'x6' skylight with louver controls. It is set in the center of the classroom, with a deep well. On a sunny day, sunlight splashes directly on the classroom floor if the louvers are not closed. Observation revealed that many of these skylights seem to have their louvers closed, presumably to reduce direct sun onto students. They were initially assigned a code of 3.

Skylight Type D is an angled, tinted clerestory, with a horizontal opening of about 2' x 6', that lights part of a wall in some formerly open classrooms. Observation revealed that areas lit by these clerestories have often been reduced to storage areas on the periphery of open classrooms. They were initially assigned a code of 2.

Skylight Louvers

Three of the skylight types have operable louvers that are manually controlled, allowing the teacher to dim the daylight. In two of the skylight types, A and AA with diffusing lenses, the louvers are controlled with a turning rod device. Over 85% of those skylights were observed to have their louvers open. On a clear summer day the skylights provided 250 fc in the center of the classroom. When closed, they provided 10-15 fc. (See sample illumination readings in Appendix) In one classroom we visited, where the louvers were closed, the teacher, new to the classroom for a summer school session, said that she didn't know how to operate them. One of her second grade students promptly popped up and offered to show her how to operate the skylight. We concluded that the student body provides an important continuity of knowledge about the operation of special features in schools.

A third skylight type, C, with a clear plastic dome, also had louvers, but controlled by an electric switch on the wall. We were told that these louvers were originally controlled by photosensors, but that they didn't work right (no further information) and so the photosensors were disabled. We did not visit any of these schools in session, and so could not interview any teachers about their actual operation. However, many were observed to be fully closed. Given that the clear skylight cast a 6' x 6' patch of full sunlight into the center of the room, it seemed logical to assume that teachers would keep them closed on any sunny day, and might get into the habit of keeping them closed much of the time.

Window Coverings

Very few classrooms had any form of daylight modulation or control for windows. Two portables had vertical blinds that were purchased by the local PTA, reportedly more to provide security for computers than light control. Perhaps 10% of the traditional classrooms still had working black-out curtains. The few teachers who used them regularly said their primary motivation was to hide computer equipment, which otherwise might be easily visible to thieves.

Teachers in classrooms with extensive window areas (codes 3-5) were observed to frequently mount artwork on the glass, so that 20%-50% of the glass area might be obstructed by paper. This seemed to occur regardless of the tint of the glass, suggesting that it was driven more by a need for additional display space than a desire to cut down the amount of light entering the room. Classrooms with small window areas (codes 1-2) were rarely observed to have artwork taped to the windows. Occasionally announcements were taped up in windows next to entry doors. Thus, it appeared that large window areas were more likely to have their daylight contributions significantly reduced by obstructions than were small window areas.

A few classrooms were observed to have furniture obstructing their windows. This was more common in portables, where lack of storage space motivated the use of tall cabinets for storage.

Air Conditioning

Most schools in Capistrano are air conditioned. Air conditioning has been a standard feature there since the 1970s. Also, many earlier schools, but not all, have been retrofitted with air conditioning. All portables have air conditioning. Since classrooms with skylighting all have air conditioning, but not all air conditioned rooms have skylights, we decided to see if air conditioning influenced the effects of skylights. Maintenance personnel searched their records and identified which schools and which classrooms had original packaged roof top air conditioning, retrofitted air-conditioning, or none. Portable classrooms were assumed to have small, wall mounted units. The type of air conditioning unit was added to the database.

Almost all classrooms in the Capistrano district have their own thermostats, and the teachers can generally decide on the operation of the systems. The maintenance personnel cautioned us that some air conditioning units were functioning poorly, or were recently repaired or replaced. However, detail about actual operation of the systems was beyond the scope of our investigations. Thus, our database reflects the presence of a system, not its condition or operation.

Operable Windows

Skylit classrooms, being air conditioned as part of the original design, also have no operable windows. We hypothesized that the lack of natural ventilation might influence results, so we also collected information about which classrooms had operable windows. Older schools and newer schools tended to have operable windows. All portables have operable windows. The presence of operable windows was added as a yes/no variable. Even though we could identify which classrooms had operable windows, we could not identify if and when those windows were opened. Many might be rusted or painted shut, or rarely used. Thus, this variable is treated as an indicator of the potential for natural ventilation.

Teachers in the older, non-air conditioned schools with ample daylight were observed to make use of their operable windows on a pleasant spring day. One teacher was extremely appreciative of the cross ventilation provided by her classroom design.

All teachers interviewed in portables reported making use of their operable windows. They considered the cross ventilation provided by windows on both narrow ends of the classroom to be an essential feature of the portables. “It can get really stuffy in here, and with colds and body odor, I try to keep as much fresh air in here as I can.”

Open Doors

In addition, from our on-site visits we observed that many teachers leave their doors open during class. This was especially true of teachers in portables. At various schools, 60-80% of the portable classrooms were observed to have their doors open, compared to perhaps 10% of the traditional classrooms. This was observed consistently in summer, fall and winter. This strategy for portables was effective because there was an operable window at the opposite end of the classroom that would allow cross ventilation, whereas most traditional classrooms do not offer through ventilation. Teachers interviewed in portables all reported that they opened the doors for ventilation, because the portable classrooms tended to get stuffy. “I open my door in the morning and leave it open all day, all year round, except for a few days if it’s really windy or cold outside, or if the playground is especially noisy.”

A door opened for ventilation also greatly increases the daylight entering the classroom. Light reflects off of the entry porch and floor and penetrates deeply into the space. For this reason, after the site visits, we up-graded the daylight rating of the portable classrooms from a 1 to a 2.

Electric Lighting

We were unable to collect sufficient information about the electric lighting conditions in the classrooms to include it in the data set. We did take illumination readings and found highly consistent levels for the electric lighting. Regardless of the vintage of the equipment it would seem that all classrooms in the district were designed to provide an average of 50 footcandles of electric lighting illumination. Within a given classroom, electric lighting levels might vary between a low of 30 to a high of 80 footcandles directly under a fixture. Most of the classrooms had some form of bi-level switching which allowed the teacher to use only one half or one third of the lights. It is not known if, or how often, such a feature was used. (In most classrooms observed in session, all of the lights were on. Those observed with electric lights off, or partially off, were usually in the midst of some special activity, such as recess, art class, or video presentation.)

In Capistrano, fluorescent lighting is universal in the classrooms. There are a variety of luminaire types, including pendant wrap around, recessed prismatic, recessed parabolic louvers, and suspended indirect. Most of the luminaires use energy efficient magnetic ballasts and T-12 lamps, but there are a considerable number of schools with T-8s and electronic ballasts which were either original in new schools, or retrofitted into older schools. While the traditional classrooms within a given school had fairly consistent lighting equipment, the portables in each school were highly variable. There was no way to verify which schools, or which classrooms, currently had which type of lighting other than by on-site inspection of every classroom, which was beyond our resources for this project.

4.2 Capistrano Analysis

We first analyzed the Capistrano data set by looking at absolute scores for one test period, spring 1998. These initial models considered all of the demographic information and the three daylighting variables ([daylight 0-5] or [windows 0-5 plus skylight 0-5]). The resulting equations were very complex, incorporating up to 25 variables, including all of the demographic information. From the point of view of the daylighting variables, these static models tended to be unstable. In general, the skylighting variable tended to show up negative or not significant, the window variable tended to show up positive or not significant, and the daylight variable did all three.

Our hypothesis was that there were one or more unknown variables strongly correlated with skylighting and windows that were confounding the results. We hypothesized that the skylight variable might be affected by the presence of air conditioning or lack of natural ventilation, since all skylit classrooms had fixed windows and air conditioning. So we collected data about the presence of operable windows, and the status of air conditioning for each classroom, and added these variables to the model.

Skylight Variables

Since the skylighting variable (0-5) seemed to be highly unstable, we also ran models looking at skylighting in different ways:

- Skylighting: yes-no
- Each skylighting code, 0-5, run separately as its own variable
- "Types" of skylights, based on their configuration rather than expected illumination levels. (described in Section 4.1.3 above)

The third approach, skylight "types," proved to be the most fruitful, producing the most consistent and significant results. It consistently distinguished between the effects of the 5 types of skylights found in the schools. All skylight types are represented at two or three schools, and all schools with skylights also have classrooms with no skylights.

From this analysis we concluded that the patterns of distribution and control of light from a skylight are more significant than the absolute illumination levels.

School Level Effects

We also hypothesized that there might be school level effects that were interacting with the presence of windows and skylights. So we added a school level variable. We were able to isolate school effects in Capistrano because each school site had more than one type of daylighting condition. Each school had at least the original traditional classrooms plus a collection of portable classrooms. [1] Some schools had three or four types, with original classrooms, additions of various vintages, plus the portables.

Approximately one half to one third of the schools showed up in the models as having a significant influence on how much a student learned over the course of the school year. The addition of a school level variable increased the precision of the model and increased our confidence that we had accounted for any effects which might be attributable to a special program, an extra highly motivated staff, an active PTA or exceptional parent participation at one school site.

[1] There is an exception, one school which consists completely of portable classrooms.

Static vs. Delta Models

Next we tested an improvement, or delta model, using the difference in scores between the fall and spring tests, rather than the absolute scores (static model). The delta model was very stable and simple. All demographic variables dropped out as insignificant. The air conditioning variable dropped out. A few of the classroom type variables remained significant in some of the models. We were left with significant positive effects in all four models for daylight, windows, and one or two of the five skylight types, and a negative effect for one skylight type.

We concluded that the delta model was the strongest approach since it isolated the effect of learning in a single physical environment during the school year, and allowed each student to serve as his/her own control.

Second Round of Site Visits

Once the model seemed very stable and robust, we conducted a second round of site visits to verify conditions at nine schools that we had not visited previously. We found a few surprises that caused us to re-adjust some of the daylight and window codes:

- Some schools, and classrooms were found to have lower transmission glass than previously reported. The daylighting codes for these classrooms were correspondingly reduced.
- Portable classrooms were found to have their doors open a great deal of the time, bringing in substantial daylight. The daylighting code for all portable classrooms was increased from 1 to 2.
- One school was found to have rebuilt some classrooms since the original plan. The window and daylight codes were adjusted to fit the actual condition.

Air Conditioning, Operable Windows and Classroom Types

After making the corrections to the data set described above, the daylighting variables decreased slightly in magnitude but remained significant. However, the pattern of significance for the classroom types, air conditioning, and operable windows once again became unstable. We studied the co-linearity among these variables and found them highly inter-related. The Pearson correlation coefficient is shown in Figure 7. For example, many of the rooms without operable windows were found to be semi-open/open rooms. The correlation between these variables created some overlapping influence and caused some of the variables to be significant in some models and insignificant in others.

While we were sure that the daylighting variables were significant, we were not sure which other physical characteristics of the classrooms should be included in the final models.

		Permanent Portable	Semi-Open/ Open Room	Air Conditioning	Operable Windows
Pearson Correlation	Semi-Open/Open Room	-.155			
	Air Conditioning	.106	.136		
	Operable Windows	.041	-.555	-.245	
	Skylight Type AA	.537	-.084	.057	.150

All correlations are significant at the 0.01 level (2-tailed).

Figure 7: Co-linear Variables

We decided that, in order to achieve greater clarity in the models, some of these variables should be eliminated in favor of others. After examination, the most satisfactory set of equations were found to include the operable window variable but not the other variables. The other choices of variables were rejected because they were not found to give consistent results across the four basic models.

The equations that included the room types were also very inconsistent. When portables, modular classrooms, and semi-open/open rooms were included in the models, instead of air conditioning and operable windows, many different results arose. The three variables surfaced with different magnitudes and signs in the four models depending on which of the three were included, indicating that there was a strong co-linearity between the variables.

These models did show that portable classrooms generally had a positive influence on change in student scores. No conclusion could be drawn about the modular classrooms since they flipped signs in the models. The semi-open/open rooms also changed signs in the models, thereby making it difficult to draw conclusions about this type of room. Indeed, there was a strong negative correlation between semi-open rooms and operable windows. Due to this correlation, the apparently positive effect of operable windows on student performance could be due to some unknown negative characteristic of semi-open rooms.

There is also a positive correlation between Skylight Type AA and the modular classroom type. Due to this correlation, it is possible that the apparent positive effect of Skylight Type AA on performance might be due to some other unknown positive characteristic of the modular classroom room type.

Air conditioning consistently showed a negative effect, but did not show up as significant in all of the models. When both operable windows and air conditioning were included in the equation, the operable windows variable was significant in three of the four models, seemingly taking over the significance of air conditioning. Once the room types were eliminated, we found that air conditioning was statistically significant in only one of the models.

A final statistical test indicated that the eliminated variables did not have a significant impact as a group on the model. The window, skylight, and daylight variables remained steady in magnitude and significance, indicating that our estimate of the effect of these variables was generally not affected by the correlation between the other variables. It was decided to also exclude the air conditioning variable based on this process.

4.3 Capistrano Results

Figure 8 summarizes the increases in test scores for the daylighting-related variables for the four Capistrano regression models. As part of the analysis we calculated the statistical certainty that these effects were a "true" effect which could be replicated in other analyses of the data. This is expressed as a percent certainty. The chart shows the value of each variable's effect, its statistical certainty, and the relative effect of each variable compared to the average progress of all students in the Capistrano District.

Capistrano	**Analysis Results**				**Percentage Effect**	
NEA Core Level Tests Range: -29 to +79	Difference in Average Test Improvement (normalized RIT points)		Statistical Certainty		Difference as a % of District Average Improvement	
Change, Fall to Spring	Reading	Math	Reading	Math	Reading	Math
Model 1						
Daylight, Min. to Max.	2.8	2.3	99.9	99.9	26%	20%
Operable Windows	0.8	-	99.8	n/s	7%	-
Model 2						
Windows, Min. to Max.	2.4	1.7	99.9	99.9	23%	15%
Skylight A	2.0	2.3	99.7	99.9	19%	20%
Skylight B	-2.2	-	94.9	n/s	-21%	-
Operable Windows	0.9	0.8	99.6	99.9	8%	7%

Figure 8: Summary Daylight Findings for Capistrano

The Capistrano Core Level Tests are reported on a special scale system called Raush Unit or "RIT." The average student in our data set progressed in reading scores by 8.8 RIT points and in math scores by 12.5 points from fall to spring[1]. For the charts in this report we have translated all the test results into a consistent scale of 1-99 in order to facilitate comparison between the districts[2]..

[1] Please note that in all cases these values are averages for our specific data set, not the district, because our data set was a sub-set of all students in the district.

[2] This was done by dividing the B-coefficient by the range of scores unique to each data set, then multiplying by 98, the number of intervals in a scale of 1-99. See the Appendix for tables with the conversion factors used for each district.

We also report the test results as a percentage effect to show the relative magnitude of the findings[1].

Daylighting was found to have a considerable effect in the Capistrano schools. For example, all other things being equal, students in classrooms with Skylight Type A were found to progress an additional 2 points in reading and 2.3 points in math (normalized)[2] than those in classrooms without skylights. This translates into a 19% faster learning rate for reading and a 20% faster learning rate for math on average for the children in those classrooms.

Summary results in the Capistrano Unified School District:

- The classrooms with the most amount of daylighting are seen to be associated with a 20% to 26% faster learning rate, as evidenced by increased student test scores over one school year, compared to classrooms with the least amount of daylighting.
- The classrooms with the most window area are seen to be associated with 15% to 23% faster rate of improvement over a one year period when compared to classrooms with the least amount of windows.
- The classrooms with the Skylight Type A are seen to be associated with a 19% to 20% faster improvement when compared to classrooms with no skylights.
- The classrooms with the Skylight Type B are seen to be associated with a 21% decrease for reading tests, and no significant results for math tests, when compared to classrooms with no skylights.
- Classrooms with operable windows are seen to be associated with 7% to 8% faster improvement in three out of four cases, when compared to classrooms with fixed windows.

Another way to look at these results is that the average child in the Capistrano district is making about 1 point of progress per month on the reading test and 1.5 points of progress per month on the math test over the course of the approximately eight months between the fall and the spring tests. Students in the most daylit classrooms are progressing more quickly, gaining one to two points more over the course of the school year than students advancing at the average rate. Thus, by advancing more quickly, students in daylit classrooms could save

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[1] For Capistrano and Seattle the following formula was used to calculate the percentage effect:
Percentage effect = (raw B-coefficient * variable range) / raw district mean .
For Fort Collins, where the scores ranged from 153 to 280, we created a normalized mean, based on a scale of 1-99. Thus, for Fort Collins:
Percentage effect = (normalized B-coefficient * variable range) / normalized district mean.

[2] Raw RIT values are 1.7 and 2.6 respectively. See appendix for charts of raw values, and conversion factors to normalized values.

up to one month of instructional time in the reading and math curriculum that could be used for other areas of learning.

Important Formatting Notes

In the body of this report, we report the effect of the daylighting variables by the "maximum effect" observed, from the lowest to highest daylighting condition at each district. Thus, if the window variable had a range of 0-5, then the B-coefficient is multiplied by five to obtain the "maximum potential effect". In cases where the variable had a smaller range, then we used that smaller range as a multiplier. For example in Seattle, where the window code only ranged from 1-4.5, then the multiplier is 3.5, not 5. Thus, the "maximum potential effect" should be interpreted as the range of effect seen between the classrooms in each district with the least and the most windows or skylights or daylighting. Because each district did not have the same range of daylighting codes the results are not strictly equivalent. We chose to take this more conservative approach to avoid any potential for over reporting the effects.

It is very important to keep in mind that the Capistrano models use the relative *change* in test scores over a school year as their measure, not absolute levels of testing. Thus, a negative B-coefficient for Capistrano means comparatively less progress than the norm, not negative progress.

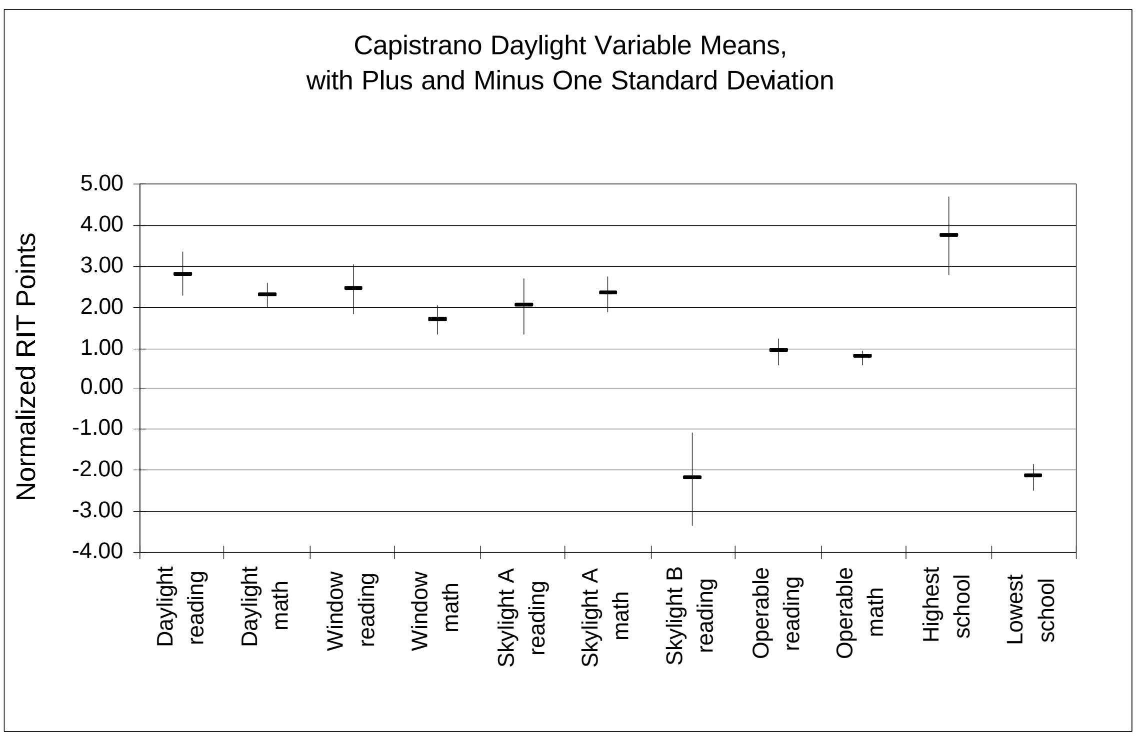

Figure 9: Capistrano Daylight Variables with Standard Deviations

Figure 9 plots the Capistrano results for the daylighting variables, this time showing the range of the standard deviations for each variable. The more precise the variable, the smaller the spread for the standard deviation. Thus the math-model variables for daylight and operable windows are seen to have relatively small standard deviations, while the Skylight B reading variable has a much larger spread, indicating that it is less precise. For comparison, the highest and lowest performing schools in the data set have been included. See the following Section 4.3.2 for a discussion of high and low schools, and other variables in the model.

Further Detail in Appendix

Full detail of the model equations are included in the Appendix. The Descriptive Statistics charts in the Appendix list the mean, minimum, maximum, and standard deviation for each variable entered into the model. These are followed by the results of the regression equation for each of the four models. These charts list the raw B-coefficient for each variable found significant in the model, along with its standard error, the student t-test, and its significance. A Beta coefficient is also reported, which measures the relative power and precision of each variable. The R^2 for each model is also reported in the caption for each chart. A second set of charts show the order of entry for each variable and the change in R-squared as that variable was added to the model. At the beginning of each district's charts is a conversion chart which lists the district mean used to calculate the percentages, and any scalar used to normalize the values reported in the text.

4.3.2 Discussion of The Regression Variables

The results for all major variables of the Capistrano regression equations are presented below in Figure 10. The Daylight, Window and Skylight variables each were run in only two of the four models, thus by definition, they have a maximum of two bars. The same set of control variables was considered in all models, and thus when a control variable was significant in all four models it has four bars in the graph. We attempt to interpret the pattern and magnitude of these findings below.

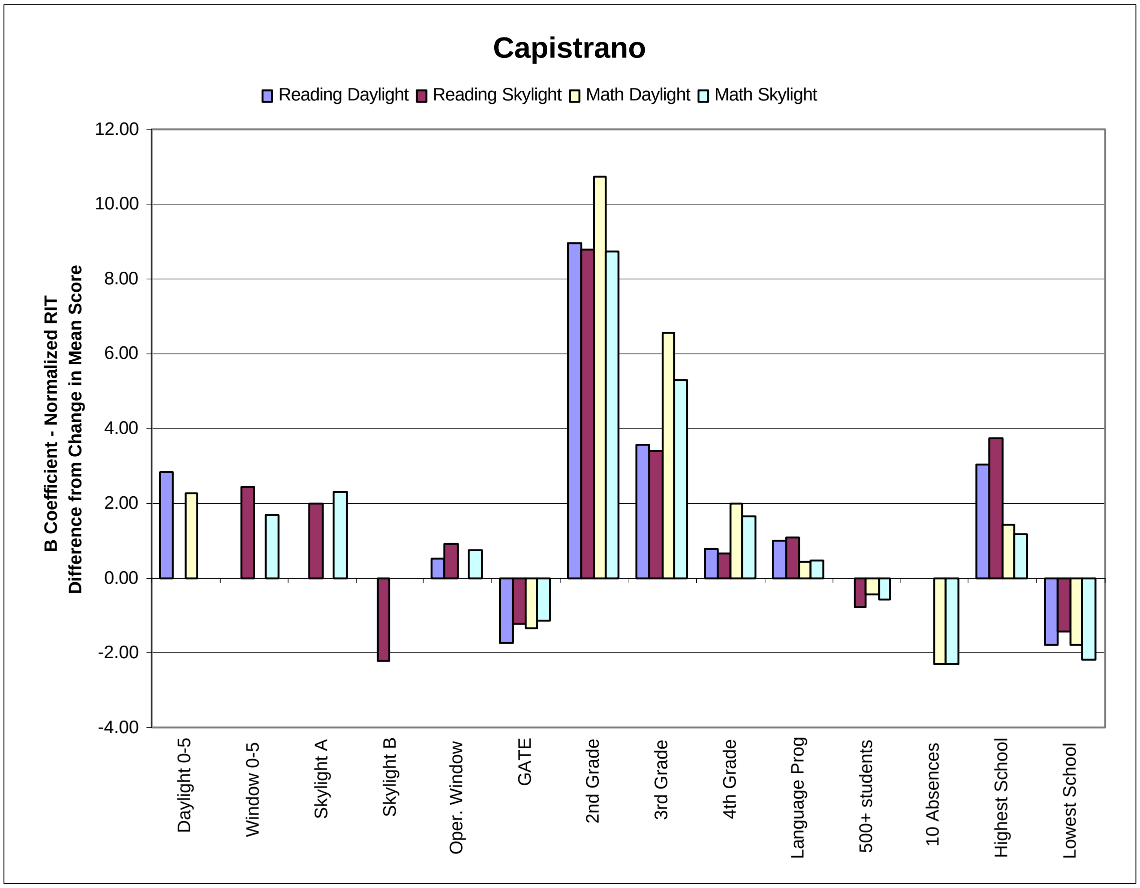

Figure 10: Capistrano, Percentage Point Difference from Change in Mean Score

Daylight, Skylights, and Windows: The daylight, window and skylight type A variables are all positive and strongly significant.

Skylight Type A had the most even light distribution of the five skylight types, fully diffused without any potential for direct sunlight to enter the room. It also allowed the teacher to control the amount of daylight with the use of manually controlled louvers.

The observation that both the daylight variable and the Skylight Type A variable have slightly larger effects than the window variables argues for the theory that the presence of daylight in and of itself, and not view or other aspects of windows, are responsible for the positive effects.

The results for the other skylight types were less compelling. The negative effect for Skylight Type B that is observed in one model might reasonably be interpreted to be a function of the glare caused by sunlight splashing on the classroom walls. Skylight Type B is a clear acrylic skylight located in the corner of the classroom, often over the teacher's desk. It is not provided with any controls to modulate the light. Thus, on sunny days, sunlight makes its way directly onto the walls or the teacher's desk. This finding suggests that control of light and/or diffusion of direct sunlight are important features to include in a classroom skylight system.

The other three skylight types, AA, C and D, had no significant coefficients. They generally have rather small populations, making them less likely to show up as significant in a model. Furthermore, each had some lighting qualities that would seem to make them less of a positive attribute to a classroom. Skylight Type AA is similar to Skylight Type A, except with a flat diffuser at the ceiling plane, rather than an inverted pyramidal diffuser recessed into a coffered ceiling. Illumination levels from Skylight Type AA are slightly lower and less uniform around the classroom. It shows a positive, but not significant, effect in one model. Skylight Type C is a clear skylight, like Type B, but located in the center of the classroom. Thus, on sunny days, sunlight will land directly on student desks, unless the louvers are closed. We observed most of them to be closed on the day we visited. It would seem likely that teachers would keep the louvers closed to avoid problems caused by direct sunlight. And if the louvers are closed much of the time, the skylight would have little effect on the learning environment. Skylight Type D is a very modest monitor type light, which provides a splash of filtered daylight over sinks in some open classroom schools.

Thus, from these findings, it would seem that the mere presence of a "patch of daylight" or "connection to the outdoors" through toplighting is not sufficient to provide positive effects. The one skylight that is consistently performing well provides high illumination levels, which are evenly distributed in the classroom. It does not allow any direct sunlight into the classroom, and also allows the teacher to easily modulate the light levels.

Operable windows were also found to have a significant, if small, positive coefficient for three out of four of the models. We posit that allowing the teacher the option of using natural ventilation when desired is a positive feature for classrooms. In general, in this district, air conditioning seemed to be associated with a negative effect. (see discussion in Section 4.2.) About half of the air conditioned classrooms also had operable windows.

There are many possible interpretations of these findings, including the effects of other co-linear variables, the mild climate in Capistrano, malfunctioning air conditioning units, or air quality issues. We would suggest that this finding deserves further study.

Grade Level: The grade level of the student tended to be the most powerful predictor of progress made between the fall and the spring tests. This is consistent with the RIT scales of the NWEA level tests, where younger grades typically make greater progress[1].

[1] More information about expectations for RIT level tests can be found at http://www.nwea.org/altexpgr.htm.

In addition California has recently mandated class size reduction for kindergarten through third grades, so that students in the lower grades can receive more attention from their teachers. The maximum student teacher ratio in those grades is 20:1, whereas in the higher grades in our data set, fourth and fifth, the ratio is commonly 30:1.

Gifted and Talented (GATE) and Bilingual Programs: Participation in a GATE program (Gifted and Talented) shows a negative effect, meaning that GATE identified children made slightly less progress in a year than non GATE children. The best explanation of this would seem to be that GATE children already score very high on the tests. Since in the RIT scaled tests, children at higher levels make less progress per year than those at lower levels, these results are consistent with expectations.

The positive effect of the bilingual program might be attributable to two further explanations, other than the obvious conclusion that the program is helping children progress more rapidly. Since the bilingual program children tend to have slightly lower actual scores than the norm, they would tend to progress faster than the norm. Alternatively, since the bilingual programs are magnet programs, they may attract more dedicated families, creating a self-selection bias for this population.

School Site: The positive or negative effects of the school site could be due to any one of a number of mechanisms. The site might have a special program, a more motivated staff, more active parents, a better neighborhood, a better location, or any number of other influences that make one school “better” than another. It is one of the strengths of the Capistrano analysis that we were able to include individual school sites as variables in the models to account for these potential effects.

It is very noteworthy that, in our analysis, the effect of moving from a classroom with the least to the most daylighting is of the same order of magnitude as the effect that would be seen by moving from an average school in the district to one of the highest, or lowest, performing schools in the district.

Unverified absences had a slight negative impact on math improvement, but not on reading improvement. Ten unverified absences have the same order of magnitude effect (negative) as learning in a skylit or daylit room (positive).

Size of school: The size of the school was found to have a small but significant negative effect. For every 500 student increase in population, performance decreases by less than one percentage point. Since the mean school population in Capistrano (for grades 2-5) is about 900 students with a standard deviation of $\pm$ 200, this is not likely to be a major effect.

The observations about the variables included in the final models are summarized below in Figure 11.

Significant Variables:	Comment
Daylight Codes	Positive effects
Grade Level	Strongest effects
GATE Program	Negative effect
School Site	Significant for 30%-45% of schools
Operable Windows	Positive in 3 of 4 models
Language Program, (bilingual immersion)	Positive, stronger for reading than math
Absences	Negative effect for math only
School Population	Slight negative effect for larger schools

Insignificant Variables:	Comment
Ethnicity	Not a factor
Socio-Econ Status	Not a factor
Age of School	Not a factor
Year Round Program	Not a factor
Tardies	Not factor
Vintage of School	Not a factor
Gender	Slightly significant in only one math model
Type of Classroom	Inconsistent findings, co-linearity with air conditioning and operable windows
Air Conditioning	Negative trend, co-linearity with operable windows
Students per class	Probably absorbed by grade level variable

Figure 11: Significant and Insignificant Variables in Capistrano

4.3.3 Stepwise Regression

The R^2 for the final Capistrano models ranged from 0.25 to 0.26. This could be interpreted to mean that about 25% of the variation in the data sets can be explained by the models. For some types of regression analysis, such as those explaining the behavior of the physical world, this might be considered to be very low. However, for regression models which deal with the behavior of individuals, which are highly variable, this is considered to be a very creditable result, and is consistent with other analyses performed with this type of data.

Figure 12 below summarizes the findings of the step regression performed to determine the relative explanatory power of each variable in the model. Variables are listed in order of entry into the model. The earlier the entry, the more powerful the variable is in predicting how a student will perform.

This chart excludes the outliers, since they are not of particular interest in interpreting results. For full detail on the step regression results, please see the Appendix.

MODEL				
Order of Entry	**Reading Daylight**	**Reading Skylight**	**Math Daylight**	**Math Skylight**
1	Second Grade	Second Grade	Second Grade	Second Grade
2	Third Grade	Third Grade	Third Grade	Third Grade
3	School 61	School 61	Fourth Grade	Fourth Grade
4	GATE	GATE	GATE	GATE
5	School 64	School 64	**Daylight**	School 72
6	**Daylight**	**Window**	School 72	**Window**
7	School 72	Language Prog	School 59	School 50
8	School 85	School 81	Absence Unverified	School 59
9	Fourth Grade	School 82	School 62	**Skylight Type A**
10	Language Prog	Fourth Grade	School 77	School Population
11	School 82	**Skylight Type B**	School 82	Absence Unverified
12	School 73	School Population	Schol 61	School 74
13	School 67	School 66	School Population	**Oper. Window**
14	School 62	School 67	Language Prog	School 62
15	**Oper. Window**	School 77	School 67	School 82
16	School 81	School 62	School 71	School 85
17	School 77	School 73	Absence Unexcused	Absence Unexcused
18		**Skylight Type AA**	**Oper. Window**	School 70
19		Female		Language Prog
20		School 60		
21		**Oper. Window**		
22		**Skylight Type A**		
23		School 72		
24		School 85		
Outliers:	6	6	6	6

Figure 12: Order of Entry for Capistrano Variables

This analysis shows that the daylight and window variables are particularly strong explanatory variables of how much a student will progress within a given year. They enter as the fifth or sixth variable into the models, exceeded in strength only by what grade the student is in or if they are in a GATE program.

Depending on the model, eight to twelve schools of the district's 27 show a significant impact on a student's progress, but this generally is less of an influence than the daylight and window conditions. The skylight and operable window variables have more variance as to when they enter the models, some in the middle and some nearer the end. Often they are seen to have more explanatory power than if the child is in a language program, the size of the school, or how many absences the child has during the year.

It makes sense that the window and daylight codes would have the strongest explanatory power of all the variables of interest, since every classroom has a code for these variables, whereas there is a much smaller population of classrooms with skylights or operable windows.

The delta R^2 for the daylighting variables varies from 0.0026 to 0.0002. This means that they are contributing about 1% to 0.1% of the explanatory power (R^2 = .25) of the model. Again, while this may seem very small, it is still comparable to the explanatory power of other commonly accepted variables included in the equations, such as the number of absences, gender, the size of the school, or participation in a special program.

4.3.4 Interactions Among Other Independent Variables

Using the daylighting - math model, we looked at interactions between daylighting and the other explanatory variables, namely school size, unverified absenteeism, unexcused absenteeism, the gate program, the language program, and the three grade level indicator variables. We first looked at scatterplots of the residuals versus each of these variables. The residual plots did not reveal any indication of interaction. As a check we created the interaction variables and measured their significance as a group. The p-value was .099 indication that there was only a weak effect at best. When we looked closer we found that there was no significant interaction with the grade variables, but there was a weak interaction between daylighting and school size (p-value = .046), and daylighting and unexcused absenteeism (p-value = .062). The estimated effect was positive for all students in the sample, but varied from .0 to 1 for most students, with the distribution centered at 0.5. The results indicate that the effect of daylighting on math performance tends to be higher in larger schools and for students with higher unexcused absenteeism.

In this exercise, we did not find any interactions that suggested that the model might be compromised by interaction effects.

4.3.5 Classroom Level Analysis

After reviewing analysis with the above regressions, using the student records as the dependent variable, there still remained a concern that the analysis might be reflecting a classroom level phenomenon. This student level analysis assumes that both teachers and students are assigned randomly to classrooms, and that there is no bias such that “better” teachers or “better” students are preferentially assigned to daylit classrooms. To test this hypothesis we conducted a classroom level analysis to see if the significance and magnitude of the daylighting variables would remain the same, or would decrease in certainty and size.

We created a new analysis database at the class level by calculating the average of the dependent and explanatory variables of each model within each classroom. For example, the number of absences was calculated as the classroom average value of the absences of each student. In the case of an indicator variable, it becomes equal to the fraction of students in the classroom. For example, since Gate_N was an indicator variable in the original model, its new value is the fraction of the students in the classroom that are in the GATE program. The same is true for the gender and the grade indicators. In the case of any class-level variable, such as the skylighting indicators, we simply used the value for the class.

We excluded the students that had earlier been identified as outliers in the student level analysis. Dropping a student from the database is essentially equivalent to including an indicator variable for the student-level analysis. We also calculated the number of students in each class and the residual standard deviation of the original student-level models.

We used weighted least squares to fit the models. We used a maximum likelihood estimation methodology to identify the most appropriate model for the residual variance of the classroom-level models. We postulated a variance-component model for the student-level model. Specifically we assumed that the random component of the test performance of each student is the sum of a classroom-specific effect that is common to all students in a given classroom, and a student-specific effect.

In the case of the math model, the classroom component of the variance was about 20% of the total variance, while the student component of the variance was about 80%. In the case of the reading model, we found no classroom component of variance. We may postulate that the classroom effects are associated with differences between teachers. In this case, these results suggest that Capistrano teachers are quite uniform in their ability to teach reading, but vary in their ability to teach math. Alternatively, classroom effects may be a function of grouping students into classrooms by abilities. It may be that the district is more likely to assign students to a given classroom based on their math ability, but not likely to track children into classrooms based on their reading ability.

The following table compares the results of the classroom level analysis with the original student level analysis. The table shows the regression output for the Skylight Type A explanatory variable for the math and reading models.

Math	B	Std Err	t	Sig
Student Level	2.556	0.469	5.449	0.000
Class Level	2.451	0.830	2.953	0.003
Reading	B	Std Err	t	Sig
Student Level	1.668	0.560	2.979	0.003
Class Level	1.932	0.728	2.655	0.008

Figure 13: Classroom Level Analysis Results for the Skylight Variable

The following points are important to observe:

- The coefficient remained stable. The math coefficient dropped slightly but the reading coefficient rose a fair amount. Neither change was statistically significant.
- The standard errors increased as we expected.
- The t-statistics fell and the significance levels became somewhat poorer. But both variables are still highly significant.

As might be expected, the R-square statistic was much higher at the class level. The math model explained 67% of the variance at the class level. The reading model explained 47% of the variance at the class level. This illustrates the fact that the R-square statistic is strongly affected by the level of aggregation.

We did not repeat the analysis of the daylight models but we would expect the results to be similar. Please see the Appendix for the full text of the Capistrano classroom level analysis.

4.4 The Seattle District

Seattle Public School District is a primarily urban school district in the city of Seattle, Washington. Its neighborhoods tend to be in the older, more densely settled areas of the city. It has also expanded by incorporating neighboring suburban districts. Elementary schools in Seattle tend to be much smaller than Capistrano, averaging (grades 2-5) 200 students in our data set.

Seattle provided us with student test score records for all elementary students attending over 60 school locations. The test scores used in the analysis are from the Iowa Test of Basic Skills (ITBS), Form M, for grades 2 to 5, for math and reading, administered in spring of 1998. These scores were analyzed using the Normal Curve Equivalent (NCE) format (see section 3.3.1). The analysis for Seattle uses the actual test scores for this one point in time, not the change in test scores between time periods.

In addition to the test scores, the data set included codes for the student's classroom location, grade, ethnicity, sex, and socio-economic status. As mentioned earlier, all information was stripped from the data set that might have allowed identification of an individual. Similar to Capistrano, a similar data cleaning effort matched the classroom codes used in the test score data set to classroom codes from other sources of information. About 90% of students could be matched to classroom locations.

4.4.1 Seattle Buildings

The elementary schools in Seattle had a large range of conditions. Mostly older, the schools range in age from 8 to 90 years old. Most are multiple story buildings with interior hallways and both indoor and covered facilities for student use, such as gymnasiums, covered play areas, libraries, cafeterias and auditoriums. Many had multiple additions over the years, but in general, daylighting conditions within a given school were fairly similar across all classrooms.

Most Seattle elementary schools have substantial windows with clear glass, although a few have minimal or no windows. There are a few “open” schools from the 1970s with “pod” classrooms that share a common space in the center. These open classroom schools typically have few if any windows. Some schools are clearly designed for full daylighting, with high ceilings (11’) and window walls on two sides of the classroom. Many schools had skylights that lit the hallways and recreation areas. These skylights outside of classrooms were not included in our analysis.

Originally we believed that nine schools had some form of toplighting in some of their classrooms. However, we were only able to verify toplighting in four schools. The most prevalent types of toplighting were sawtooth monitors, some facing east, some facing north. One school with open-type classrooms has clerestory windows that allow daylight deep into the building. A handful of classrooms have three small skylights, and another group have large central skylights with louvers covering most of the ceiling. Please see the Appendix for photographs of selected classroom conditions.

We examined historical records, a maintenance database, aerial photographs, and architectural plans of each school, to create a classroom database that added the following information, linked to the homeroom location of each student:

- Square footage of classroom
- Square footage of school
- Traditional, open (pods) or portable classroom
- Age of school (original construction date)
- Daylighting code
- Window code
- Skylight code

As with Capistrano, on-site investigations were conducted twice. We visited a number of schools initially to scope out the range of daylighting conditions, in order to develop the daylighting codes as they were applied to this district. After the data set was developed and the draft analysis completed, we visited nine additional schools to confirm exceptional conditions. Given that Seattle is such a large district, with 60 schools, we were only able to conduct on-site visits to about 25% of the schools.

During a site visit to a skylit school, it became clear that there was a high population of gifted students in this school in a special “accelerated” program. We realized that we didn’t have a gifted indicator for the Seattle data. The district was unable to provide it by student, so they created a “gifted room” identifier, that located classrooms across the district with more than 70% gifted children where an accelerated curriculum was pursued. Adding this variable to the analysis reduced the resulting coefficient for skylights, and daylight.

Daylight Code	Number Of Students	Window Code	Number Of Students	Skylight Code	Number Of Students
1.00	369	1.00	419	.00	7089
1.50	70	1.50	70	1.50	8
2.00	599	2.00	599	2.00	20
2.50	285	2.50	235	2.50	50
3.00	4334	3.00	4674	3.00	278
3.50	146	3.50	146	3.50	145
4.00	1272	4.00	1363		
4.50	84	4.50	84		
5.00	431				
Grand Total	7590	Grand Total	7590	Grand Total	7590

Figure 14: Daylight Codes, Seattle Public Schools

The chart in Figure 14 shows the distribution of daylight codes in our data set for the Seattle district. The vast majority of classrooms had a window code of 3 (average) and no skylights.

Other Conditions

The Seattle district has very few portable classrooms. There was also little variation of daylighting conditions within a school site. Thus we did not have the same opportunity to add a site variable to the analysis as we did in Capistrano.

We were told that no schools in Seattle had air conditioning, and that most have operable windows. Most of the schools have fluorescent lights. A recent project has been retrofitting T-8 lamps and electronic ballasts in some schools, but most schools during the time period of this study had older systems, mostly T-12 lamps and magnetic ballasts. A number of schools had an incandescent lighting system. We were unable to add information about the lighting system to the analysis.

4.4.2 Seattle Results

The Seattle analysis found a similar pattern of positive, significant results for the daylighting variables. These results were not only significant, but remarkably consistent in magnitude across all four models.

Figure 15 summarizes the effects for the daylighting-related variables of the four Seattle models. The chart first shows the B-coefficient for the reading and math scores on the NCE scale of 1-99. All these variables were found to have 99.9%

certainty. The percent effect of these scores relative to the district average score (reading: 57, math: 59[1]) is reported in the right column. The full results of the Seattle analysis are included in the Appendix at the end of this report.

Seattle	Analysis Results				Percentage Effect	
ITBS Iowa Test of Basic Skills NCE Scale 1-99	Difference in Average Test Scores (NCE percentage points)		Statistical Certainty		Difference as a % of District Average Score	
Spring Scores	Reading	Math	Reading	Math	Reading	Math
Model 1						
Daylight, Min. to Max.	7.5	5.6	99.9%	99.9%	13%	9%
Model 2						
Windows, Min. to Max.	7.7	8.7	99.9%	99.9%	13%	15%
Skylights, Min. to Max.	3.9	3.4	99.9%	99.8%	7%	6%

Figure 15: Summary Daylight Findings for Seattle

All other things being equal, students in classrooms with the largest window area, or the most daylight, were found to be testing 9% to 15% higher than those students with the least window area or daylighting. A 6% to 7% effect is observed for skylit classrooms.

The Regression Equations

The results for all the major variables of the Seattle regression equations are presented below in Figure 16. There are many more variables than for Capistrano, since this is a static model. Demographic variables become important in predicting a student's actual score, rather than improvement, as in Capistrano. We attempt to interpret these findings below.

The magnitude of the **daylighting variables** is considerably larger in Seattle than Capistrano (6-9 points vs. 2-3 points for windows and daylighting). There are a number of possible explanations. It may partially be a function of a less detailed model, which can account for fewer other influences, such as the role of each school site. It may reflect a bias of students with higher initial test scores attending schools with more daylight. Or it may reflect a cumulative effect of daylighting over a longer time period.

[1] Again, these values are the district average for the data set used in this study, which is a subset of the whole district.

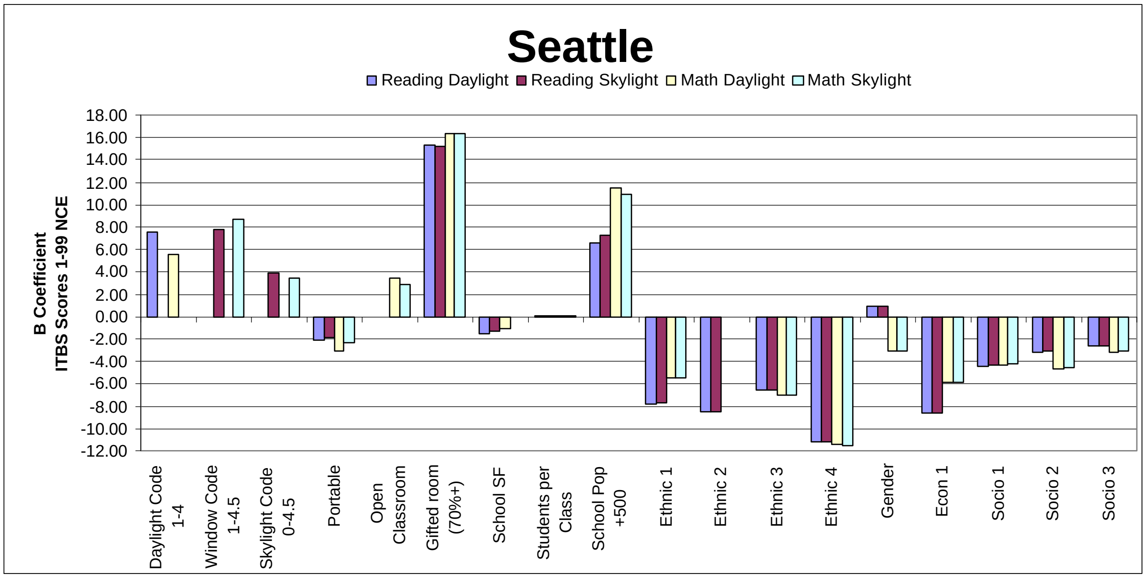

Figure 16: Seattle, Percent Point Difference in Mean Score

It should be remembered that these models looked at actual test scores, not the change between two periods. Thus, they reflect levels of achievement attained over a student's career to date, rather than improvement over one year. It is possible then, assuming that most students stay at one school site, that the effects of daylighting might be cumulative over a student's career, and thus larger than for a single school term.

In the Seattle analysis, we tried some models that distinguished between the skylight types. We wanted to see if the type or orientation of the skylight made a significant difference in performance. In general the skylight codes showed positive results of similar magnitude. There were no significant differences between toplighting systems that faced north, versus those that could let the sun in (facing east or south). However, the significance of each variable was often reduced, since we were dealing with smaller populations. We concluded that in this district it was more meaningful to leave the skylight variable on the 0-5 scale.

The **gifted room** variable has the greatest magnitude of effect. As would be expected, students in a gifted program are seen to be scoring about 15 points higher than the mean.

The **school population** variable shows a strong positive effect, so that the larger the school, the better students perform. This might seem to be contradictory to findings from other studies. However, given the very small size of the Seattle schools (mean is 200 students in grades 2-5), this may indicate that these schools are below an optimum size. Or it may be that larger schools in Seattle have some other advantage, such as better facilities.

The **demographic variables**—ethnicity, economic and social status—are seen to have a strong influence. However, it is interesting that mostly their magnitude is equal to, or less than, the daylighting variables.

Other variables, portable classrooms, open classroom, school square feet, students per class, have occasional and modest impacts.

The R^2 for the Seattle models at $R^2 = 0.26$ to 0.30, are just slightly higher than for Capistrano.

Stepwise Regression

Order of Entry	**Reading Daylight**	**Reading Skylight**	**Math Daylight**	**Math Skylight**
1	econ 1	econ 1	Ethnic 4	Ethnic 4
2	Gifted room (70%+)	Gifted room (70%+)	Gifted room (70%+)	Gifted room (70%+)
3	Ethnic 4	Ethnic 4	econ 1	econ 1
4	Ethnic 2	Ethnic 2	Grade 2	Grade 2
5	Grade 2	Grade 2	Gender	Gender
6	Ethnic 1	Ethnic 1	Grade 3	Grade 3
7	Grade 3	Grade 3	Ethnic 1	Ethnic 1
8	Ethnic 3	Ethnic 3	School Pop	School Pop
9	School Pop	**Window**	Ethnic 3	Ethnic 3
10	**Daylight**	Students per Class	Socio 3	Socio 3
11	Students per Class	School Pop	Socio 2	Socio 2
12	Socio 3	Socio 3	Socio 1	Socio 1
13	Socio 1	**Skylight**	Vintage	**Skylight**
14	Square Feet	Socio 1	Open rm	**Window**
15	Socio 2	Socio 2	**Daylight**	Open rm
16	Gender	Square Feet	Portable	Students per Class
17	Portable	Gender	Students per Class	Portable
18	Grade 4	Grade 4	Square Feet	
19		Portable		
# Outliers	5	6	3	5

Figure 17: Order of Entry for Seattle Variables

When we look at the step regression to see the order of entry for the variables, the daylighting variables fall in the middle range for the reading models, and the lower end of the range for the math models. The delta R^2 for the daylighting variables are similar to Capistrano, at 0.003 to 0.001. While these values are small, Figure 17 shows that the daylighting variables do have more explanatory power than variables that might commonly be considered important indicators of a student's achievement, such as social status (single family households) or the number of students in a classroom.

4.5 The Fort Collins District

The Poudre School District in Fort Collins, Colorado is a rapidly growing school district about an hour north of Denver, situated in the college town for Colorado State University. The district has many new facilities, some of which include aggressively daylit classrooms which are lit from rooftop windows, called sawtooth monitors. These schools have relatively modest windows. But other, older schools, have larger window areas. The range of daylighting conditions seemed to present a good opportunity for our study.

4.5.1 Fort Collins Data

The Fort Collins district provided us with data sets of student test scores for math and reading "level" tests for spring of 1998 and 1997 for 23 schools. These level tests for math and reading, developed by Northwest Educational Association, are similar to the tests used in the Capistrano analysis. They use an RIT scale that allows comparison of scores across all levels. The data sets also included demographic information, similar to Seattle and Capistrano, including grade level, ethnicity, gender, socio-economic status, and special education codes.

From examination of district records we added information to the database about the age and the size of the school. We examined architectural plans for each school to determine classroom type (open vs. traditional classrooms), and develop the daylight, window and skylight codes. We also created density variables similar to Seattle, using students per school, and number of classrooms per school, neither of which proved to be a significant variable in the final models.

Similar to Seattle, students identified with special education and bilingual codes and special academies were removed from the data set. The final 1998 data set included about 5700 students grades 2 through 5. The 1997 data was much less complete, so we did not use it in our analysis.

Economic Status

The economic status variables that were available for this study (free and reduced lunch) do provide a useful indicator for the low end of the economic scale, but they do not provide an indicator for the high end of the economic scale.

As an initial screening measure, we reviewed school locations relative to the economic class of neighborhoods with district personnel, and concluded that there was probably enough socio-economic variation within both the skylit and the non-skylit schools to avoid a strong confounding effect of economic class by school. Although the skylit schools did constitute all of the newer schools in the district, there was a wide range of ages of schools in the district (44 years), so it was felt that an age variable would have enough variation to effectively capture any vintage effects independent of the skylights. For example, if older schools were associated with both higher economic status and larger window areas, then that effect should be reflected in the coefficient for the age of the school.

School Level Analysis

Unfortunately, due to the structure of the data sets given to us by Fort Collins, we were not able to identify students by their classroom location. The finest grain information we could obtain was the grade level of student per school location. As a result we had to analyze the Fort Collins student performance data by school location, rather than by classroom location. This was a serious drawback, and reduced the precision of our analysis for Fort Collins. This limitation was partly ameliorated by the observation that daylighting conditions throughout a given school site are quite similar. Fort Collins schools did not have portable classrooms, or classroom wings of different vintages, and window types and sizes do not tend to vary much within a school plan. However, given the school-level of the analysis, it is not possible for us to distinguish between potential school level effects and daylighting conditions within a school for the Fort Collins analysis.

4.5.2 Fort Collins Buildings

The district has recently built seven schools using the same basic plan with large overhead monitors in the classrooms, and modest vision windows in each classroom. Older schools tend to have larger windows. The oldest schools in the district have been retired to other uses.

We again categorized the window and skylight conditions by review of architectural plans. We applied the same criteria for assigning codes that had been used in Capistrano and Seattle. The final coding in Fort Collins was much simpler and more general, because it was, by necessity, at the school level, rather than by classroom. There was considerable, but not absolute, uniformity between daylighting conditions for each classroom within a school. We certainly could not account for orientation or obstructions specific to a classroom. To create a window code for each school, we averaged the window to floor area ratio for the classrooms in each school. These averages fell into three distinct groupings, that were assigned the following codes:

Window code 1	1-2%% window to floor ratio
Window code 2	3-4%% window to floor ratio
Window code 3	8-13%% window to floor ratio

South-Facing Monitors

In the skylit schools, the monitors run the length of each classroom, and have angled, un-shaded glass facing due south. They have semi-diffusing glass, either sand blasted or “solar glass,” to diffuse the direct sunlight. On-site observations determined that fuzzy images can be seen through the monitors, indicating that the glass is only partially diffusing. Illumination measurements were made at some schools, indicating that the south facing clerestories provide very high levels of illumination in the middle and back of the classrooms (100-150 fc), but the south end of the classrooms tends to be darker (40-60 fc). This represents roughly a 10% daylight factor. In one classroom during a sunny period, 450 fc were measured in a corner of the room. (See Appendix for sample illumination readings and photographs of classrooms.)

The monitors are also provided with opaque insulating shades that are designed to operate on an automatic schedule, closing every night and opening every morning. The teacher has an override, which allows the room to be darkened at will. The principals of a few schools were interviewed to explain the typical operation of the shades. They believed that the shades were primarily closed only in the early fall and late spring to avoid overheating, and during video presentations. However, on-site observation of five schools on a partly cloudy day in February found 60% of the shades closed during the school day.

We hypothesized that the very bright light from the monitors was disturbing to the teachers, who tended to close the shades. An interview with the architect confirmed that teachers at one time had complained about how bright the monitors were. The response had been to design monitors with a slightly less transmissive glass (-05%) and to move the teaching wall for some of the teachers to the east or west wall of the classroom. Currently a majority (±60%) of the teaching walls are perpendicular to the monitors.

In the final models, the monitors were treated as a yes/no variable. Rooms with a monitor were assigned a daylight code of 5, based on our expectations of high illumination levels. In retrospect, given that the monitors seemed to be closed much of the time, this may have been an overestimate.

Daylight Code	Number of Students	Window Code	Number of Students	Skylight Code	Number of Students
1	2092	1	2092	0	4027
2	1106	2	3652	1	2239
3	829	3	522		
5	2239				
Grand Total	6266	Grand Total	6266	Grand Total	6266

Figure 18: Daylight Codes for Fort Collins

Other Characteristics

None of the schools in Fort Collins have air conditioning. The skylit schools do have a thermostat activated venting system that exhausts hot air from the top of the monitors. Information about air conditioning and natural ventilation was not included in our analysis for this district.

All of the schools visited in Fort Collins have fluorescent lighting, but we could not confirm that fluorescent lighting was universal in all schools. The skylit schools have pendant mounted direct/indirect fixtures which appear to have T-8 lamps. Information about electric lighting was not included in our analysis for this district.

4.5.3 Fort Collins Results

The Fort Collins analysis found a similar pattern of positive, significant results for the daylighting variables. These results are normalized to a 1-99 scale, just as with the other districts. Data used to normalize the results and calculate the percentage effects are included in the Appendix.

Fort Collins	**Analysis Results**				**Percentage Effect**	
NEA Core Level Tests Normalized Scale 1-99	Difference in Average Test Scores (normalized RIT points)		Statistical Certainty		Difference as a % of District Average Score	
Spring Scores	Reading	Math	Reading	Math	Reading	Math
Model 1						
Daylight, Min. to Max.	3.8	3.4	99.9%	99.9%	7%	7%
Model 2						
Windows, Min. to Max.	10.2	7.0	99.9%	99.9%	18%	14%
Skylight Monitor	-	1.6	n/s	99.7%	-	3%

Figure 19: Summary Daylighting Findings for Fort Collins

The Fort Collins results in Figure 19 show a 7% improvement in test scores in those classrooms with the most daylighting, and a 14% to 18% improvement for those students in the classrooms with the largest window areas. There is a 3% effect for math scores in the classrooms with the roof top monitors and no significant effect on reading scores.

The Fort Collins results may be influenced by a number of factors which are distinctive about this district. First of all, we had the least amount of information about the characteristics of the students and schools in the Fort Collins district. Therefore, there is the greatest likelihood that there are other variables which we have not accounted for that are influencing the findings.

Secondly, the district has only a modest range of window conditions. There were no classrooms in Fort Collins without any windows, and no classrooms with really large window areas, or what we considered “full” daylighting. Because of this limited range of window conditions in our model, the effect of going from a minimum to maximum window condition may be unreported.

Finally, the skylighting variable is considerably weaker in these models than in Seattle, having only a small positive magnitude for math, and no significance for reading. We believe that the weak positive effect of the skylight variable may be a function of poor lighting quality from the south facing monitors, and the observation that many teachers seem to keep the shades down to solve this lighting quality problem. One would expect that skylights that are closed off much of the time would not have much of an effect.

The results for the daylighting variable may also be depressed for the same reason, since the daylighting code was a function of the skylighting code. We assigned the classrooms with skylights the highest daylight code for our analysis, on the expectation that they would have the highest daylight illumination levels. We didn't know the extent of the glare problems or the operation of the shades until after the analysis was completed.

The Regression Equations

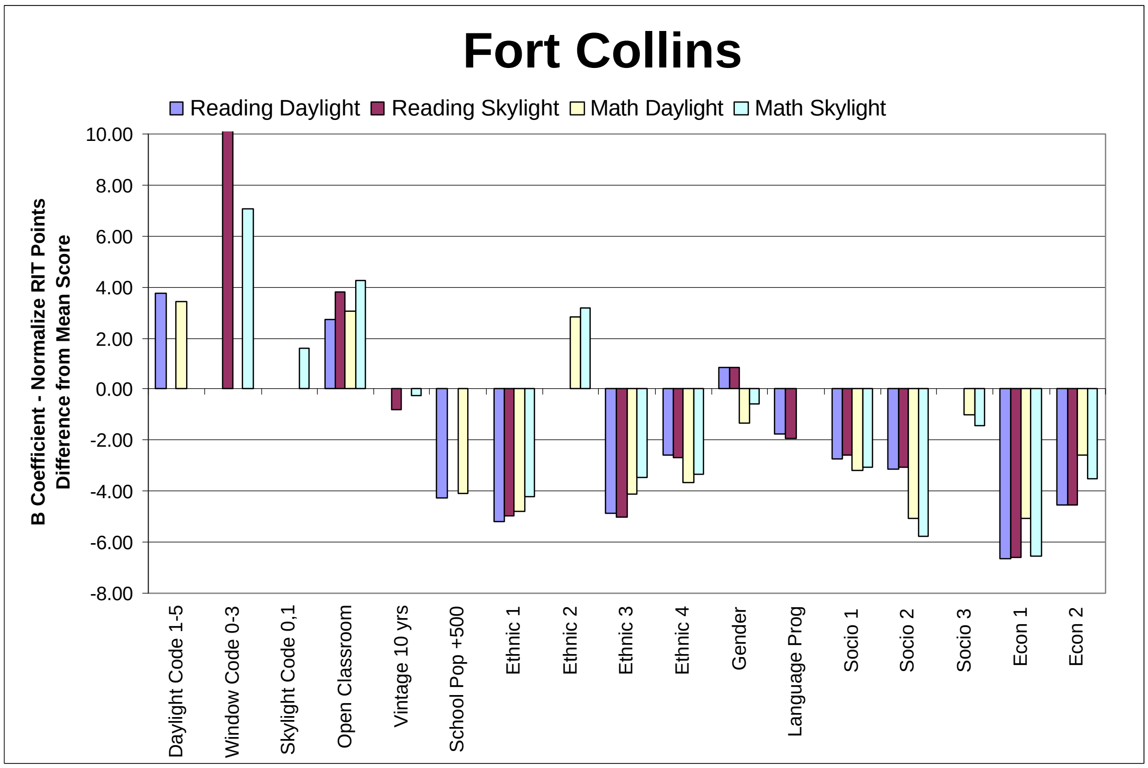

Figure 20: Fort Collins Percentage Point Difference in Mean Score

The B-coefficients for the variables in Fort Collins regression equations in Figure 20 show a very similar pattern to Seattle. Indeed, the very similarity of the results for the diverse variables across districts argues for the validity of the models. With a different mix of immigrant populations between the two cities, the shifts in the ethnicity variables seem reasonable. The positive daylight variables have a similar magnitude to the negative demographic variables. Thus, one's assignment to a daylit classroom would seem to be as significant as one's ethnicity in determining performance on the standardized tests.

In general, due the limitations of the Fort Collins data, we did not explore the impact of other variables for this data set. Because of the uniformity of the schools, and our inability to distinguish between the daylighting conditions in various classrooms, it is much more likely that there are specific school effects which are confounded with the daylighting conditions particular to a given school.

The R^2 for the Fort Collins models is considerably higher than the Capistrano or Seattle models (0.37 to 0.44). The delta R^2's for the daylighting variables also have a similar range, 0.001 to 0.004.

The order of entry for the daylighting variables is similar to Seattle, in the middle to low range, with less influence on the math models than the reading models. In general, we would expect the Fort Collins daylighting variables to have less effect, since defined on a school wide level, rather than a classroom level, they had less accuracy than the other districts.

Variable	MODEL:			
Order of Entry	**Reading Daylight**	**Reading Skylight**	**Math Daylight**	**Math Skylight**
1	GRADE3	GRADE3	GRADE3	GRADE3
2	GRADE4	GRADE4	GRADE4	GRADE4
3	Economic 1	Economic 1	Economic 1	Economic 1
4	Ethnic 1	Ethnic 1	GRADE5	GRADE5
5	GRADE5	GRADE5	Ethnic 1	Ethnic 1
6	School Pop	Economic 2	Economic 2	Economic 2
7	Economic 2	VINTAGE	Gender	Gender
8	**Daylight**	Ethnic 3	Ethnic 2	Ethnic 2
9	OpenClass	Socio 1	Socio 2	VINTAGE
10	Ethnic 3	LANGPROG	Socio 1	Socio 2
11	LANGPROG	Gender	Ethnic 3	Socio 1
12	Socio 1	**Window**	Ethnic 4	Socio 3
13	Gender	OpenClass	Socio 3	Ethnic 4
14	Socio 2	Socio 2	**Daylight**	Ethnic 3
15	Ethnic 4	Ethnic 4	OpenClass	OpenClass
16			School Pop	**Window**
17				**Skylight Code 0,1**
18				School Pop
Outliers:	8	8	9	4

Figure 21: Order of Entry for Fort Collins Variables

5. DISCUSSION AND CONCLUSIONS

We began this study uncertain that we would be able to find any significant effects of daylighting using a regression analysis methodology on large student performance data sets. We pursued the study of three school districts in the hope that at least one district would be amenable to this analysis technique. As a result of our work, uncertainty has transformed to certainty, and many new areas of investigation are suggested.

From this study, we have made a number of important findings:

- We found a uniformly positive and highly significant correlation between the presence of daylighting and student performance in all three districts.
- We found that daylighting, provided from skylights, distinct from all the other attributes associated with windows, has a positive effect.
- We found that this methodology, of using large pre-existing data sets, can be a successful and powerful tool for investigating the effects of the physical environment on human performance.

There are many uncertainties that remain. This kind of observational study cannot determine a causal relationship. We have merely shown an association between the presence of daylight and higher student performance, not shown that daylighting causes students to learn more. Daylighting seems to be a good predictor of student performance, but there are other possible associations that might be involved in this correlation. The most obvious one is that there is some bias of “better” teachers being assigned to classrooms with more daylight.

Other lesser findings can also be derived from this study, discussed below, and in the body of this report. We consider whether the magnitude of findings between the districts is significant, and why they may exist. We also consider whether there are lessons to be learned about the importance of windows per se versus daylight illumination, and what our findings suggest about the design of daylighting systems to achieve the best human performance. These discussions are purely speculative, based on our interpretation of the findings from the data in combination with our observations as architects visiting the school sites.

Finally, we consider possible physiological mechanisms whereby daylighting might cause higher performance. We relate some of these hypotheses to work that has been done by others. Again, at this point, all of these potential causal mechanisms are purely speculative, and will require more focused research to resolve.

5.1.1 A Possible Teacher Effect

The most outstanding question remaining from this study is whether there is a correlation between “better” teachers and classrooms with more daylight. We use the term “better” teacher as a catch-all for whatever qualities in a teacher might result in the higher student test scores observed in the analysis. This might be a function of teachers with more seniority or training or experience being assigned to classrooms with more daylight. It might be a function of teachers in daylit classrooms being more motivated or alert or responsive to students.

We attempted to address this issue in two ways in the study. First we informally interviewed teachers, principals and administrators in the district to see if we could identify any bias in how teachers were assigned to classrooms. This is a touchy subject, and teacher privileges are not freely discussed. We could not, however, detect an obvious systematic bias. We were told of senior teachers who preferred the portables, of schools organized around themes, classes grouped by grade level, and (in Capistrano) the constant reshuffling of classroom assignments due to population growth and class size reduction.

Teachers did strongly and consistently express a preference for classrooms with operable windows. Increasing ventilation seems to be very high on their priority list for classroom characteristics. There was also some implication that a view was desirable, so it is possible that more senior teachers might be more likely to end up with classrooms with a view. A view might correlate with larger windows, but would not correlate with skylights. In one seasoned administrator’s perspective, daylighting would have to correlate with five or six other factors that teachers strongly prefer in classrooms—such as carpets, sinks, storage space, new furnishings—in order for daylighting to have a bias in teacher selection of classrooms.

The second way that we attempted to address this issue was by performing the classroom-level analysis for Capistrano discussed earlier. The results of that investigation showed that a classroom level analysis, such as would be influenced by differences among teachers, was not particularly more accurate than a student level analysis.

Neither of these investigations, however, is conclusive. There are other possible approaches that might help to answer this question with further investigation.

1.) We could try to correlate data describing teacher experience, such as years of service and highest degree, with classroom location to see if there was a correlation between daylighting and experience. This would be most useful in a district like Capistrano where teachers could be assigned to different daylight conditions within a school. In districts like Seattle, or Fort Collins, with little variation in daylighting conditions within the school, such a correlation might just indicate a school preference.

2.) We could try to survey a sample of teachers to see what their perceptions are about classroom assignments, and their preferences for various classroom attributes. We could then correlate preference for daylighting with teacher characteristics, such as experience, and simultaneously find out the relative importance of daylighting in teacher preferences compared to other classroom attributes.

If teachers are indeed sorting themselves out so that those in daylit classrooms are getting better results—because they have more tenure, are better trained, more motivation, better stamina, whatever—then we may have described a "teacher bias" effect for daylight, rather than a "student performance" effect of daylight. There would seem to be two possibilities in this scenario. One, that daylight is inspiring better performance in teachers, or two, that the better teachers all manage to end up in the more daylit classroom. It would be nice to know which, but either way, as school administrator, it might be advantageous to have more daylit classrooms, if only as a competitive position against other districts competing for the best teachers.

5.1.2 Comparisons Between Districts

The results of the analysis of the three districts are remarkably consistent: all positive, in the range of a 2-9 percentage points effect, and all with 99% certainty of a valid effect. This is a remarkable finding.

Figure 22 on the following page presents the summary findings for the daylighting variables for all three districts. The reasons for differences between districts are interesting to consider, although they cannot be known based on the results of our study. The magnitude of the Capistrano test score effects (left column) are the smallest of the three districts, but this is to be expected for a number of reasons:

- **Operable Windows**: The Capistrano model isolates the positive effect of operable windows, which may be included in the Seattle and Fort Collins results for the window variable. We did not collect information about operable windows in Seattle or Fort Collins.
- **School Site Effects**: The Capistrano model controls for more variables, especially the individual school sites, which is likely to reduce the observed effect for all other variables, including the daylighting variables. Thus, with the inclusion of the school site variable in Capistrano, we would expect the B-coefficient of the daylighting variables to be reduced.
- **Cumulative Effects:** The delta scores for Capistrano report on the improvement over one school year, whereas the other two districts report on actual test scores at a given point in time, which presumably include the effect of the initial starting point at the beginning of the year. Thus, the Capistrano results can be interpreted as a yearly improvement effect, while the other two districts may be reflecting more of a cumulative effect of having been at a well

daylit school over a number of years, averaged over the range of grades 2-5. It should also be remembered that the daylighting conditions within a given school in Seattle and Fort Collins are relatively homogeneous, which would reinforce any possible cumulative effect, whereas the daylighting conditions within a given school in Capistrano can be quite dissimilar (from portables to traditional classrooms), which would tend to reduce any cumulative effect. Further study is clearly needed to test this hypothesis.

Capistrano	**Analysis Results**				**Percentage Effect**	
NEA Core Level Tests Range: -29 to +79	Difference in Average Test Improvement (normalized RIT points)		Statistical Certainty		Difference as a % of District Average Improvement	
Change, Fall to Spring	Reading	Math	Reading	Math	Reading	Math
Model 1						
Daylight, Min. to Max.	2.8	2.3	99.9	99.9	26%	20%
Operable Windows	0.8	-	99.8	n/s	7%	-
Model 2						
Windows, Min. to Max.	2.4	1.7	99.9	99.9	23%	15%
Skylight A	2.0	2.3	99.7	99.9	19%	20%
Skylight B	-2.2	-	94.9	n/s	-21%	-
Operable Windows	0.9	0.8	99.6	99.9	8%	7%

Capistrano Delta Normalized Results

Seattle	**Analysis Results**				**Percentage Effect**	
ITBS Iowa Test of Basic Skills NCE Scale 1-99	Difference in Average Test Scores (NCE percentage points)		Statistical Certainty		Difference as a % of District Average Score	
Spring Scores	Reading	Math	Reading	Math	Reading	Math
Model 1						
Daylight, Min. to Max.	7.5	5.6	99.9%	99.9%	13%	9%
Model 2						
Windows, Min. to Max.	7.7	8.7	99.9%	99.9%	13%	15%
Skylights, Min. to Max.	3.9	3.4	99.9%	99.8%	7%	6%

Seattle Normalized Results

Fort Collins	**Analysis Results**				**Percentage Effect**	
NEA Core Level Tests Normalized Scale 1-99	Difference in Average Test Scores (normalized RIT points)		Statistical Certainty		Difference as a % of District Average Score	
Spring Scores	Reading	Math	Reading	Math	Reading	Math
Model 1						
Daylight, Min. to Max.	3.8	3.4	99.9%	99.9%	7%	7%
Model 2						
Windows, Min. to Max.	10.2	7.0	99.9%	99.9%	18%	14%
Skylight Monitor	-	1.6	n/s	99.7%	-	3%

Poudre Normalized Results

Figure 22: Comparison of Three Districts

5.1.3 Other Possible Discrepancies

The other districts may also have higher (or lower) results for other reasons having to do with the information in our data sets:

- **Unknown Co-linearity**: The Seattle, and especially the Fort Collins, data sets are not as thoroughly reviewed and refined as the Capistrano data, and thus might include errors or co-linearity with unknown variables, which could either raise or lower the results. We uncovered one such correlation in Seattle with the gifted students program. There may be others that we were unable to observe.
- **Compressed Daylight and Window Scales**: The Seattle and the Fort Collins results are derived from compressed scales. For example, in Fort Collins no windows were graded above a scale of 3. In Seattle, the highest window code was 4.5. Simple extrapolation suggests if the two districts had some classrooms with larger window area, which could have been assigned a code of 5, that the maximum window effect for those districts might have been even larger. We were not able to conduct any tests to see how sensitive the analysis is to the range of daylight codes.
- **Sub-Optimum Daylight Design**: The Fort Collins skylight variable is for a skylight condition that lighting experts generally consider to be less than optimum. Poor lighting quality would presumably lower the positive effect associated with skylighting. Furthermore, a large percentage of the skylights may have their shades closed during class time, which would also greatly reduce any potential effect.
- **Neighborhood Effects**: Large windows may be associated with more prestigious neighborhoods. Older schools tend to have bigger windows, and if these older schools tend to occur in older, established, leafy neighborhoods, larger windows may also have an association with higher income households. Any such correlation in Capistrano would be captured in the school site variables, since the influence of a particular neighborhood would be seen at the school level. However, we could not control for such influences in Seattle and Fort Collins. We did control for age of the school, so if this older school/larger windows/better neighborhood hypothesis is true, part of the effect should be absorbed in the age of school variable. We also controlled for free and reduced lunch, which can be used to characterize the low end of the economic scale, but there were not similar variables to capture any effects due to students at the high end of the economic scale.

  At the beginning of the analysis, we did a reality check in each district to make sure that the skylit schools did not have an exclusive relationship to high-income neighborhoods, but we did not perform a similar check for the range of window size. Currently, if “better” schools—due to a more motivated staff, more involved or highly educated parents, or whatever—are associated with more daylighting in Seattle or Fort Collins, our model cannot distinguish between any daylighting effect and any "better" school or neighborhood effect.

- **Inaccurate Daylight and Window Codes**: In Capistrano the skylights were carefully studied. We tested the sensitivity of the skylight codes and determined the most accurate characterization of the toplighting for that district. We may not have achieved as much accuracy in the daylight codes and window codes, especially for Seattle and Fort Collins, since those districts were not as extensively visited as Capistrano. In Fort Collins it was observed on one day that the skylights were closed in 60% of the classrooms. If this is typical, then the daylighting codes for that district would be overestimating the amount of daylight typically occurring in the classrooms, and would likely result in a finding of a reduced effect. In Seattle, there were also black out curtains observed in many skylights, but most were observed to be open. If the additive effect of windows and skylights differs from what we expect, then the results for the combined daylight code would also shift.

5.1.4 Lessons about Daylight

In Capistrano the daylighting effect is seen to be slightly larger than the window effect. This is interesting, because in Capistrano the daylight scale was adjusted to more closely reflect the daylight levels observed on site, and the window scale was adjusted to more closely reflect the size of the window independent of the amount of daylight entering. Thus, this one finding strongly suggests that there is a daylight effect, and that the potential amount of daylight in a classroom is an important consideration.

The positive effect seen for skylights in all three districts also reinforces the thesis that daylighting in and of itself is important, in addition to whatever other attributes of windows may influence behavior, such as view, communication, ventilation, or status.

The results of the analysis are also suggestive of some lessons specific to the design of skylights and windows. We discuss these design issues here for the sake of school officials and designers who wish to consider including more daylighting in the design of schools[1].

[1] Readers who are interested in design issues are urged to consult some of the many excellent texts on daylighting, including *Tips for Daylighting with Windows* downloadable from http://eande.lbl.gov/BTP/pub/designguide/ or the *Skylighting Guidelines*, downloadable from www.energydesignresources.com.

Design Issues

It is clear from our analysis some of the skylighting systems considered in this study perform well and some do not. Our analysis showed more consistency when considering skylight systems by design type, rather than by the 0-5 illumination scale assigned by the daylighting experts. In other words, the way that the system was designed to affect light quality in the room seemed to be more significant than how we ranked the systems for the quantity of illumination expected.

The systems that performed well (Skylight Types A and AA in Capistrano, sawtooth monitors, clerestories and skylights in Seattle) generally had the following characteristics:

- They provided wide, diffuse distribution of daylight, by using diffusing lenses and/or diffusing louvers and wells.
- They prevented direct penetration of sunlight into the classrooms
- They allowed the teacher direct control of the amount of daylight illumination through the use of louvers or blinds

The skylight systems that did not perform as well, or that even had negative effects, (Skylight Type B and C in Capistrano, sawtooth monitors in Fort Collins) had some of the following characteristics:

- They allowed direct sunlight into the classrooms,
(or partially diffuse sunlight, as in Fort Collins)
- They relied on automatic controls, which were not performing as originally intended
- They created small areas of very high daylight illumination, which contrasted with other areas in the classroom with relatively little daylight

In our observations of schools for this study it was clear that successful daylighting from windows prevented the penetration of direct sunlight into classrooms. In general, the architects of the schools we visited seemed likely to make sure that windows were deeply shaded, and/or to include provisions for modulation of the daylight entering the rooms through the windows. Security concerns seemed to be the main reason teachers were motivated to use blinds or curtains that would make the windows opaque. However, some well-designed daylit classrooms also offered the capability to incrementally adjust the amount of light through the use of operable blinds.

5.1.5 Hypotheses for Causal Mechanisms for A Daylighting Effect

This study has established a positive correlation between higher test scores and the presence of daylight in classrooms. However, this type of study cannot prove that daylighting actually causes the students to learn more or perform better.

Other types of studies, such as carefully focused laboratory studies or intervention studies in the field, are required to identify what mechanisms may be involved for daylighting to cause such an effect. Now that it has been shown that there is a likely correlation, such studies should be conducted.

Daylight is quite a complex phenomenon and there are many pathways whereby it might have an effect on human beings. Certainly, more than one pathway may be operating simultaneously. We also do not know if it has a uniform effect on people, or affects some more than others. Below, we discuss a number of possible explanations. At this point, they are at the level of hypotheses, extrapolated from other research, or our own informal investigations. .

Improved Visibility due to Higher Illumination Levels

It is clear from our illumination measurements of the skylit classrooms in all three districts that they tend to have significantly higher illumination levels than other classrooms. Daylighting is highly variable, and so these illumination levels change by the time of the day, and by season, and thus, it is not possible to be precise about how much additional illumination is provided. The base illumination is obviously the electric lighting system. Maximum illumination is probably achieved on sunny days, depending on the type of skylight and for which season the design is optimized. Figure 23 below summarizes the maximum and minimum illumination levels that we observed in the classrooms. From these observations it is clear that illumination levels three to ten times higher than electric lighting are at least occasionally observed in these classrooms. Daylighting levels from windows are probably much less, but when added to the existing base of electric illumination, will still result in significantly higher illumination levels.

District:	Min. Observed Electric Illumination Levels	Max. Observed Skylight Illumination Levels
Capistrano	30 footcandles	400 footcandles[A]
Seattle	30 footcandles	85 footcandles[B]
Fort Collins	30 footcandles	450 footcandles[A]

Figure 23: Max. and Min. Classroom Illumination Levels

[A] Sunny Day, point location [B] High Overcast

Higher illumination levels have repeatedly been shown to increase the visibility of tasks and the speed and accuracy of people performing those tasks[1].

[1] See page 91, *Lighting Handbook*, 8th Edition, Illuminating Engineering Society of North America, 1993.

Improved Visibility due to Improved Light Quality

It has been hypothesized that daylight has better “light quality” that is more appropriate for human visual tasks, and thereby increases the visibility of the task, independent of the illumination levels. “Light quality” is a holistic term which typically includes a number of attributes of the lit environment that are generally considered to be favorable. These are often described to include:

- Better distribution of light
- Better spectral distribution
- Absence of flicker
- Sparkle or highlights on three dimensional objects

We’ll discuss each in turn.

Better distribution of light relates to how the light falls in a space, and which surfaces are well illuminated. In electric lighting design for the typical office (after which many classroom lighting systems are patterned) most of the light is directed downwards towards the desk top. Thus, horizontal surfaces are more brightly illuminated than vertical surfaces.

In contrast, daylight is a very diffuse source of light, and tends to more evenly illuminate surfaces in all directions—up, down and sideways. Daylight entering from a window also tends to most brightly illuminate vertical surfaces, such as walls and the sides of people’s faces.

Since classroom tasks involve a great deal of looking at people, and learning from material displayed on the walls of the classroom, it may be that the stronger vertical component of daylight improves visibility in this way.

Better spectral distribution relates to the wavelengths of radiation included in the light source. Daylight has a continuous spectrum, whereas most electric sources are strong in some areas of the spectrum and weak in others. The spectrum of daylight does change dramatically throughout the day, as the sun moves through the sky. However, as a continuous spectrum, daylight renders all colors well, and in tones that we tend to consider most “natural.” Better spectral distribution may improve the visibility of the learning environment by making colors more vivid.

Absence of flicker relates to the oscillations in light levels that occur in electric lighting due to the light source’s response to alternating current. People have complained that flicker is responsible for a multitude of problems, including headaches, eye strain, and attention deficit problems.

Daylight has no oscillations. Fluorescent lamps run on magnetic ballasts can have a noticeable flicker. Fluorescent lights run on electronic ballasts cycle hundreds of times faster, and so have dramatically reduced flicker problems. Incandescent lamps generally are not perceived to have flicker problems.

Studies have shown that people working under fluorescent lights with electronic ballasts have higher productivity than people working in similar conditions under lights with magnetic ballasts[1]. It may be that the reduction of flicker due to the presence of daylighting has a similar effect. Daylighting would tend to diminish the effects of flicker from magnetic ballasts by providing a steady base level of illumination.

If we were able to distinguish daylight effects between classrooms with and without magnetic ballasts, we might be able to isolate this potential mechanism.

Sparkle or highlights on three-dimensional objects may be another aspect of lighting quality from daylight. Since a daylight source (window or skylight) is generally the brightest surface in the room, it tends to cause differential illumination on three-dimensional objects with highlights and soft shadows. This might also be described as semi-directional lighting. Artists will tell you that they prefer daylight in their studios partly for the way that the shadows and highlights make objects more attractive and easier to understand three dimensionally. A similar effect may make objects more memorable for students in the learning environment.

A brief story: in one informal experiment we conducted, a teacher in a room with no windows, and with highly diffuse fluorescent fixtures, complained that the lighting in her room was much too dim. Illumination readings showed the classroom averaged about 50 footcandles, similar to all others in the district. When we opened the door, allowing some daylight into the room, she exclaimed: “See! That’s so much better!” Illumination readings barely showed an increase in illumination levels, with at best an additional 5 footcandles at horizontal surfaces near the door and less on vertical surfaces around the room. These levels of change are generally considered imperceptible. However, every object in the room now did have highlights and sparkle. Corners and edges of objects became more defined. It seems possible that she had interpreted “flat” light to mean “dim” light.

Improved Health

Daylight might improve performance through better long term health. A number of researchers have attempted to demonstrate these connections. For the Capistrano data set we considered attempting to see if there was a correlation between absences and daylighting. However, the number of students with repeated absences is a greatly reduced number than the overall population. This small population decreases the chances of finding significant effects, so we did not pursue this tact.

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[1] Veitch and Newsham, “Lighting Quality and Energy-Efficiency Effects on Task Performance, Mood, Health, Satisfaction and Comfort,” IESNA Journal, Vol 27, Number 1, Winter 98.

While exposure to daylight is widely believed to promote health, the actual biological pathways are less certain. Exposure to daylight is well known to increase the production of Vitamin D. The high illumination levels associated with daylight have also recently become recognized as a treatment for seasonal affective disorder (SAD). The timing of exposure to high illumination levels seem to be key to helping regulate our circadian rhythms[1]. Bright light suppresses the production of melatonin, a brain hormone, and increases alertness. Melatonin, which is secreted primarily at night, triggers a host of biochemical activities which may effect our immunological functions, including the production of estrogen. A recent article in *Science News* summarizes medical research on the relationship of exposure to light and cancers. A number of studies conducted in England and Sweden suggest that there may be a relationship between exposure to light and some types of estrogen-related cancers[2]. While these studies are somewhat controversial, what is certain is that there are complex biochemical pathways whereby exposure to light may influence our overall health.

Daylight Deprivation

The higher effect found for windows and daylight in Seattle and Fort Collins might be a function of greater sensitivity to indoor daylight exposure than exists in Capistrano students.

The Seattle and Fort Collins schools are very different from the Capistrano schools in one very important way: they tend to have double-loaded interior hallways, and ample indoor facilities, such as libraries, gymnasiums, and cafeterias, such that children can spend all day indoors. This is of course necessary in a rainy or cold climate. Capistrano schools, on the other hand, typically have no interior hallways, play spaces, or eating areas. Therefore the Capistrano school designs require a student to go outside five or six times a day, for every recess, and trip to the bathroom, library or administration. The climate in Capistrano, of course, is also more amenable to outdoor play. It rarely rains, never snows, and is sunny and warm most of the year. Thus, Capistrano children are inevitably exposed to the daylight outdoors much more frequently than Seattle or Fort Collins children.

One would expect the Capistrano children to be less sensitive to subtle changes in daylight exposure in the classroom since they had such a large exposure during the rest of the day, outside of the classroom. In Seattle, for example, with shorter days during the winter, and persistent cloudy weather, children may have less exposure outside of the classroom, and therefore, incremental changes within the classroom may have more influence. If exposure to daylight improves long term health, then it would follow that the children in Seattle and Fort Collins

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[1] Boivin, D.B., Duffy, J.F., Kronauer, R.E., Czeisler, C.A., "Sensitivity of the Human Circadian Pacemaker to Moderately Bright Light", Journal of Biological Rhythms, Vol 9, Nos 3-4, 315-331, 1994.

[2] Rafoff, J "Does Light Have a Dark Side?" Science News, Volume 154, No 16, October 17, 1998.

would be more sensitive differences in classroom exposure, and might show a greater range of effects.

Improved Mood

Most people will tell you that they like daylight because it is more “natural[1].” When asked to elaborate, they are likely to say, “it just makes me feel better,” or happier, or more content. While the exact mechanism may be unclear, it is certain that they think that daylight improves their mood.

Daylight may help the students directly by improving their mood, or indirectly, by improving the mood of the teachers. Most teachers we interviewed felt that windows and daylight improved the mood of their students, keeping them calm and improving their attention spans. Indeed, a number of teachers we interviewed in daylit classrooms specifically manipulated the lights to affect the children’s mood. They frequently turned off all the electric lights during story time or art periods, to help the children calm down and expand their imaginations.

The teachers that we interviewed were absolutely sure that a view through a window lowered their stress level. One teacher in Capistrano summarized this experience well: “When I’ve had it with the kids and I can’t answer another question, I just take a minute, look out the window at the view, and then I’m OK. I’m calm and ready to go back into the fray.”

Higher Arousal Levels

It is know that high illumination levels cause higher arousal levels by suppressing the production of melatonin (see above). Thus, it is possible that the higher illumination levels in daylit classrooms simply help to keep children more alert and capable of absorbing new information. If this is true, then merely providing more illumination, above the threshold level for melatonin suppression, from any source, should have positive consequences.

However, it would seem that the variability of daylight may also contribute to higher arousal levels. By creating an environment that is non-uniform in time, it may engender greater interest throughout the day. A number of classic studies have shown that patients in hospitals recover more quickly, have fewer complications, and clearer memories of their treatment when they are treated in rooms with a daylight and/or a view[2]. The positive treatment results are generally interpreted to be a result of the added stimulus from the variability of daylight or a

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[1] Heschong Mahone Group, “Skylighting Baseline Study,” December 1998 for Pacific Gas and Electric, contract 460 000 8215. 67% of people interviewed sited “more natural light” as the primary advantage of skylighting.

[2] Wilson, L.M., “Intensive Care Delirium. The effect of outside deprivation in a windowless unit” Archives of Internal Medicine, (1972) 130 225-226. Also: Ulrich, R., "View Through Window May Influence Recovery from Surgery", Science, Vol. 224, 420-421, 1983, and Keep, P., James, J., Inman, M., "Windows in the Intensive Therapy Unit", Anathesia, Vol 35, 257-262, 1980

view. In one study patients with a view of trees did better than those with a view of a brick wall. In another study, patients with an obscured window that only allowed in diffused daylight did better than those with no window.

Improved Behavior

A number of teachers and parents have suggested that daylight improves behavior, both by increasing focus and sociability. Stories have surfaced of children with attention deficit disorder (ADD) who can perform better under daylight than fluorescent light. We know of no conclusive research in this area, however, a study observing the behavior of school children in daylit classrooms in Sweden is suggestive.

Kuller and Lindsten in Sweden conducted a study of 90 elementary school students and carefully tracked their behavior, health, and cortisol (a stress hormone) levels during a one year period in four classrooms. The four classrooms had different combinations of daylighting and fluorescent lighting conditions. They concluded that there were strong correlations between the amount of daylight and the student's behavior, especially ranked for sociability and concentration. Children in classrooms with daylight tended to have typical seasonal and daily rhythms, while children in the classroom with only warm white fluorescent light showed aberrant patterns of both behavior and cortisol production. This study takes a holistic view of student performance, recognizing that there is a time for both arousal and calm, a time for cooperative social behavior and individual concentration. It is the mismatch of moods within a classroom that they find problematic, rather than a particular individual's behavior. The authors concluded: "The results indicate, work in classrooms without daylight may upset the basic hormone pattern, and this in turn may influence the children's ability to concentrate or co-operate, and also eventually have an impact on annual body growth and sick leave.[1]"

[1] Kuller, R and Lindsten, C "Health and Behavior of Children in Classrooms with and without Windows", Journal of Environmental Psychology, (1992) 12, 305-317.

6. APPENDICES

6.1 Statistical Charts

6.2 Report on Classroom-level Analysis for Capistrano

6.3 Sample Illumination Readings

6.4 Classroom Plans and Sections

6.5 Photographs of Schools and Classrooms

6.1 Statistical Charts

Capistrano School District Tabular Results

Capistrano Conversion Factors
Count of Students by Daylight Codes
Reading Descriptive Statistics
Math Descriptive Statistics
Readying Daylight Model
Reading Skylight Model
Math Daylight Model
Math Skylight Model
Readying Daylight Model Order
Reading Skylight Model Order
Math Daylight Model Order
Math Skylight Model Order

Seattle School District Tabular Results

Seattle Conversion Factors
Count of Students by Daylight Codes
Reading Descriptive Statistics
Math Descriptive Statistics
Readying Daylight Model
Reading Skylight Model
Math Daylight Model
Math Skylight Model
Readying Daylight Model Order
Reading Skylight Model Order
Math Daylight Model Order
Math Skylight Model Order

Fort Collins School District Tabular Results

Fort Collins Conversion Factors
Count of Students by Daylight Codes
Reading Descriptive Statistics
Math Descriptive Statistics
Readying Daylight Model
Reading Skylight Model
Math Daylight Model
Math Skylight Model
Readying Daylight Model Order
Reading Skylight Model Order
Math Daylight Model Order
Math Skylight Model Order

6.1.1 Capistrano School District Tabular Results

Capistrano Conversions	Reading	Math
Low score	-22	-29
High score	59	79
Range	81	108
Scalar 1-99 scale	1.21	0.91
District mean	8.83	12.51
Daylight Code Ranges	B-coefficient multiplier	
Daylight 0-5	5	5
Window 0-5	5	5
Skylight A	1	1
Skylight AA	1	1
Skylight B	1	1

Table 1: Capistrano Conversion Factors

Window Code	Number of Students	Daylight Code	Number of Students	Skylight Type	Number of Students
0	942	0	942	A SKYLIT	492
1	5317	1	1435	AA SKYLIT	279
2	932	2	3849	B SKYLIT	350
3	420	3	953	C SKYLIT	336
3.5	139	3.5	139	D SKYLIT	106
4	184	4	390	No Skylight	6705
4.5	120	4.5	120		
5	214	5	440		
Grand Total	8268	Grand Total	8268	Grand Total	8268

Table 2: Count of Students by Daylight Code, Capistrano

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Daylight Code	8268	.000	5.000	2.029	1.241
Window Code	8268	.000	5.000	1.364	1.093
Skylight Type A	8268	.000	1.000	.060	.237
Skylight Type AA	8268	.000	1.000	.034	.181
Skylight Type D	8268	.000	1.000	.013	.113
Skylight Type B	8268	.000	1.000	.042	.201
Skylight Type C	8268	.000	1.000	.041	.197
Operable Windows	8268	.000	1.000	.607	.488
School pop-per 500	8268	.808	3.036	1.759	.403
Vintage	8268	2.000	64.000	17.666	13.295
Absences Unexcused-per 10	8268	.000	6.000	.532	.536
Absences Unverified-per 10	8268	.000	1.200	.011	.062
Econ 3	8268	.000	1.000	.147	.203
Ethnic 1	8268	.000	1.000	.147	.354
Ethnic 2	8268	.000	1.000	.050	.218
Ethnic 3	8268	.000	1.000	.003	.050
Ethnic 4	8268	.000	1.000	.015	.121
Ethnic 5	8268	.000	1.000	.013	.111
Ethnic 6	8268	.000	1.000	.002	.040
Gender	8268	.000	1.000	.508	.500
GATE prog	8268	.000	1.000	.135	.342
Grade 2	8268	.000	1.000	.268	.443
Grade 3	8268	.000	1.000	.245	.430
Grade 4	8268	.000	1.000	.250	.433
Lang prog	8268	.000	1.000	.172	.377
Students per Class	8268	5.000	44.000	23.896	5.886
Tardies	8268	.000	105.000	4.742	8.541
Year Round	8268	.000	1.000	.120	.325
Sch 59	8268	.000	1.000	.032	.176
Sch 60	8268	.000	1.000	.041	.198
Sch 61	8268	.000	1.000	.067	.251
Sch 62	8268	.000	1.000	.044	.204
Sch 64	8268	.000	1.000	.020	.142
Sch 65	8268	.000	1.000	.031	.173
Sch 66	8268	.000	1.000	.032	.176
Sch 67	8268	.000	1.000	.053	.224
Sch 69	8268	.000	1.000	.064	.245
Sch 70	8268	.000	1.000	.035	.185
Sch 71	8268	.000	1.000	.034	.180
Sch 72	8268	.000	1.000	.066	.248
Sch 74	8268	.000	1.000	.043	.202
Sch 76	8268	.000	1.000	.046	.210
Sch 77	8268	.000	1.000	.050	.218
Sch 78	8268	.000	1.000	.043	.203
Sch 79	8268	.000	1.000	.041	.198
Sch 81	8268	.000	1.000	.056	.229
Sch 82	8268	.000	1.000	.043	.203
Sch 84	8268	.000	1.000	.029	.169
Sch 85	8268	.000	1.000	.062	.241
Sch 173	8268	.000	1.000	.031	.172
Sch 273	8268	.000	1.000	.024	.152
Reading Delta (sp98-fa97)	8166	-22.000	59.000	8.829	9.102
Valid N (listwise)	8166				

Table 3: Capistrano Reading Descriptive Statistics

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Daylight Code	8268	.000	5.000	2.029	1.241
Window Code	8268	.000	5.000	1.364	1.093
Skylight Type A	8268	.000	1.000	.060	.237
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Skylight Type D	8268	.000	1.000	.013	.113
Skylight Type B	8268	.000	1.000	.042	.201
Skylight Type C	8268	.000	1.000	.041	.197
Operable Windows	8268	.000	1.000	.607	.488
School Pop-per 500	8268	.808	3.036	1.759	.403
Vintage	8268	2.000	64.000	17.666	13.295
Absences Unexcused-per 10	8268	.000	6.000	.532	.536
Absences Unverified-per 10	8268	.000	1.200	.011	.062
Econ 3	8268	.000	1.000	.147	.203
Ethnic 1	8268	.000	1.000	.147	.354
Ethnic 2	8268	.000	1.000	.050	.218
Ethnic 3	8268	.000	1.000	.003	.050
Ethnic 4	8268	.000	1.000	.015	.121
Ethnic 5	8268	.000	1.000	.013	.111
Ethnic 6	8268	.000	1.000	.002	.040
GATE Prog	8268	.000	1.000	.135	.342
Gender	8268	.000	1.000	.509	.500
Grade 2	8268	.000	1.000	.268	.443
Grade 3	8268	.000	1.000	.245	.430
Grade 4	8268	.000	1.000	.250	.433
Lang Prog	8268	.000	1.000	.172	.377
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Sch 59	8268	.000	1.000	.032	.176
Sch 60	8268	.000	1.000	.041	.198
Sch 61	8268	.000	1.000	.067	.251
Sch 62	8268	.000	1.000	.043	.204
Sch 64	8268	.000	1.000	.020	.142
Sch 65	8268	.000	1.000	.031	.173
Sch 66	8268	.000	1.000	.032	.176
Sch 67	8268	.000	1.000	.053	.224
Sch 69	8268	.000	1.000	.064	.245
Sch70	8268	.000	1.000	.035	.185
Sch 71	8268	.000	1.000	.034	.180
Sch 72	8268	.000	1.000	.066	.248
Sch 74	8268	.000	1.000	.043	.202
Sch 76	8268	.000	1.000	.046	.210
Sch 77	8268	.000	1.000	.050	.218
Sch 78	8268	.000	1.000	.043	.203
Sch 79	8268	.000	1.000	.041	.198
Sch 81	8268	.000	1.000	.056	.229
Sch 82	8268	.000	1.000	.043	.203
Sch 84	8268	.000	1.000	.029	.169
Sch 85	8268	.000	1.000	.062	.241
Sch 173	8268	.000	1.000	.031	.172
Sch 273	8268	.000	1.000	.024	.152
Math Delta (sp98-fall97)	8150	-29.000	79.000	12.507	7.906
Valid N (listwise)	8150				

Table 4: Capistrano Math Descriptive Statistics

Coefficients[a]

		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	3.025	.298		10.153	.000
	Daylight Code	.464	.085	.063	5.473	.000
	Operable Windows	.643	.212	.035	3.041	.002
	GATE prog	-1.452	.257	-.055	-5.628	.000
	Grade 2	10.860	.251	.524	43.324	.000
	Grade 3	4.298	.254	.204	16.890	.000
	Grade 4	.937	.252	.045	3.727	.000
	Lang prog	.838	.239	.035	3.521	.000
	Sch 61	2.195	.370	.061	5.922	.000
	Sch 62	1.584	.477	.035	3.319	.001
	Sch 64	2.517	.638	.039	3.940	.000
	Sch 67	1.359	.416	.033	3.265	.001
	Sch 72	-1.460	.376	-.040	-3.882	.000
	Sch 77	.863	.428	.020	2.011	.044
	Sch 81	.990	.431	.025	2.295	.022
	Sch 82	1.668	.449	.037	3.714	.000
	Sch 85	-1.255	.388	-.033	-3.237	.001
	Sch 173	1.527	.516	.029	2.962	.003
	O17	41.349	7.922	.050	5.220	.000
	O28	-37.469	7.926	-.046	-4.727	.000
	O50	36.543	7.916	.044	4.617	.000
	O58	35.565	7.923	.043	4.489	.000
	O71	40.681	7.925	.049	5.133	.000
	O82	39.651	7.917	.048	5.009	.000

a. Dependent Variable: Reading Delta (sp98-fa97)

Table 5: Capistrano Reading Daylight Model R^2=0.246

Coefficients[a]

		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	4.561	.595		7.661	.000
	Window Code	.405	.099	.048	4.087	.000
	Skylight Type A	1.668	.560	.043	2.982	.003
	Skylight Type AA	.443	.513	.009	.861	.388
	Skylight Type B	-1.826	.934	-.040	-1.954	.051
	Operable Windows	.750	.263	.040	2.856	.004
	School pop-per 500	-.636	.292	-.028	-2.175	.030
	GATE prog	-1.489	.258	-.056	-5.757	.000
	Gender	-.292	.176	-.016	-1.663	.096
	Grade 2	10.630	.254	.512	41.781	.000
	Grade 3	4.097	.257	.194	15.968	.000
	Grade 4	.785	.254	.038	3.098	.002
	Lang prog	.896	.244	.037	3.680	.000
	Sch 60	-.911	.482	-.020	-1.891	.059
	Sch 61	2.497	.393	.069	6.342	.000
	Sch 62	1.670	.483	.037	3.456	.001
	Sch 64	2.649	.644	.041	4.105	.000
	Sch 66	1.109	.646	.021	1.714	.087
	Sch 67	1.389	.418	.034	3.319	.001
	Sch 72	-1.195	.453	-.033	-2.642	.008
	Sch 77	.865	.443	.020	1.950	.051
	Sch 81	3.103	.790	.078	3.923	.000
	Sch 82	1.969	.456	.044	4.321	.000
	Sch 85	-1.202	.490	-.032	-2.457	.014
	Sch 173	1.176	.554	.022	2.122	.034
	O17	41.764	7.920	.051	5.273	.000
	O28	-37.713	7.924	-.046	-4.759	.000
	O50	36.169	7.918	.044	4.568	.000
	O58	35.679	7.922	.043	4.504	.000
	O71	40.887	7.923	.050	5.161	.000
	O82	39.552	7.915	.048	4.997	.000

a. Dependent Variable: Reading Delta (sp98-fa97)

Table 6: Capistrano Reading Skylight Model R^2=0.248

Coefficients[a]

		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	8.022	.408		19.682	.000
	Daylight Code	.504	.067	.079	7.481	.000
	School Pop-per 500	-.508	.198	-.026	-2.567	.010
	Absences Unverified-per 10	-2.636	1.226	-.021	-2.150	.032
	Absences Unexcused-per 10	-.260	.143	-.018	-1.815	.070
	GATE Prog	-1.237	.223	-.054	-5.546	.000
	Grade 2	9.709	.215	.539	45.129	.000
	Grade 3	5.929	.219	.323	27.084	.000
	Grade 4	1.811	.216	.100	8.373	.000
	Lang Prog	.492	.205	.023	2.406	.016
	Sch 59	-1.090	.435	-.024	-2.505	.012
	Sch 61	.897	.313	.029	2.863	.004
	Sch 62	1.446	.395	.037	3.662	.000
	Sch 67	.837	.355	.024	2.359	.018
	Sch 71	.803	.429	.018	1.873	.061
	Sch 72	-1.614	.321	-.051	-5.026	.000
	Sch 77	1.166	.365	.031	3.197	.001
	Sch 82	1.197	.379	.031	3.159	.002
	O02	-34.466	6.830	-.048	-5.046	.000
	O18	35.115	6.838	.049	5.136	.000
	O32	62.456	6.835	.088	9.137	.000
	O33	34.059	6.838	.048	4.980	.000
	O45	-40.309	6.830	-.056	-5.902	.000
	O48	-46.423	6.831	-.065	-6.796	.000

a. Dependent Variable: Math Delta (sp98-fall97)

Table 7: Capistrano Math Daylight Model R^2=0.256

Coefficients[a]

		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	8.621	.429		20.111	.000
	Window Code	.372	.079	.051	4.684	.000
	Skylight Type A	2.556	.469	.077	5.449	.000
	Operable Windows	.835	.192	.051	4.338	.000
	School Pop-per 500	-.601	.210	-.030	-2.828	.005
	Absences Unverified-per 10	-2.534	1.234	-.020	-2.057	.040
	Absences Unexcused-per 10	-.292	.143	-.020	-2.032	.042
	GATE Prog	-1.235	.223	-.054	-5.533	.000
	Grade 2	9.611	.216	.533	44.482	.000
	Grade 3	5.837	.220	.318	26.557	.000
	Grade 4	1.804	.217	.099	8.290	.000
	Lang Prog	.513	.217	.025	2.385	.017
	Sch 59	-1.898	.439	-.043	-4.323	.000
	Sch 60	-2.347	.407	-.059	-5.765	.000
	Sch 62	1.312	.407	.033	3.214	.001
	Sch70	-1.265	.458	-.030	-2.773	.006
	Sch 72	-2.383	.372	-.075	-6.404	.000
	Sch 74	-.851	.388	-.022	-2.194	.028
	Sch 82	1.207	.387	.031	3.110	.002
	Sch 85	-1.089	.409	-.033	-2.665	.008
	O02	-33.927	6.832	-.048	-4.965	.000
	O18	35.609	6.824	.050	5.218	.000
	O32	61.504	6.833	.086	9.001	.000
	O33	34.274	6.833	.048	5.015	.000
	O45	-40.338	6.823	-.057	-5.912	.000
	O48	-45.852	6.833	-.064	-6.710	.000

a. Dependent Variable: Math Delta (sp98-fall97)

Table 8: Capistrano Math Skylight Model R^2=0.258

Variable	B	**Order of Entry**	**Change in R^2**
Grade 2	10.860	1	0.184
Grade 3	4.298	2	0.026
Sch 61	2.195	3	0.006
GATE prog	-1.452	4	0.004
71	40.680	5	0.003
17	41.348	6	0.002
82	39.650	7	0.002
Sch 64	2.517	8	0.002
28	-37.470	9	0.002
50	36.543	10	0.002
58	35.564	11	0.002
Daylight Code	0.464	12	0.001
Sch 72	-1.460	13	0.002
Sch 85	-1.254	14	0.002
Grade 4	0.937	15	0.001
Lang prog	0.838	16	0.001
Sch 82	1.668	17	0.001
Sch 173	1.528	18	0.000
Sch 67	1.359	19	0.000
Sch 62	1.584	20	0.000
Operable Windows	0.643	21	0.001
Sch 81	0.990	22	0.000
Sch 77	0.863	23	0.000
(Constant)	3.025		
		Model R^2	**0.246**

a. Dependent Variable: Reading Delta (sp98-fa97)

Table 9: Capistrano Reading Daylight Order

Variable	B	**Order of Entry**	**Change in R^2**
Grade 2	10.629	1	0.184
Grade 3	4.097	2	0.026
Sch 61	2.497	3	0.006
GATE prog	-1.489	4	0.004
71	40.886	5	0.003
17	41.763	6	0.002
82	39.551	7	0.002
Sch 64	2.649	8	0.002
28	-37.714	9	0.002
50	36.169	10	0.002
58	35.678	11	0.002
Window Code	0.405	12	0.002
Lang prog	0.896	13	0.001
Sch 81	3.103	14	0.001
Sch 82	1.969	15	0.001
Grade 4	0.785	16	0.001
Skylight Type B	-1.826	17	0.001
School pop-per 500	-0.637	18	0.001
Sch 66	1.109	19	0.001
Sch 67	1.389	20	0.001
SCH 68	0.865	21	0.001
Sch 62	1.670	22	0.001
Sch 173	1.176	23	0.000
Skylight Type AA	0.443	24	0.000
Gender	-0.292	25	0.000
Sch 60	-0.911	26	0.000
Operable Windows	0.750	27	0.000
Skylight Type A	1.668	28	0.000
Sch 72	-1.195	29	0.000
Sch 85	-1.202	30	0.001
(Constant)	4.561		
		Model R^2	**0.248**

a. Dependent Variable: Reading Delta (sp98-fa97)

Table 10: Capistrano Reading Skylight Order

Variable	B	Order of Entry	Change in R^2
Grade 2	9.741	1	0.149
Grade 3	5.929	2	0.064
32	62.456	3	0.007
Grade 4	1.811	4	0.006
48	-46.423	5	0.004
GATE prog	-1.237	6	0.003
45	-40.309	7	0.003
Daylight Code	0.504	8	0.003
Sch 72	-1.614	9	0.003
18	35.115	10	0.002
02	-34.466	11	0.002
33	34.059	12	0.002
Sch 59	-1.090	13	0.001
Absences Unverified-per 10	-2.636	14	0.001
Sch 62	1.446	15	0.001
Sch 77	1.166	16	0.001
Sch 82	1.197	17	0.001
Sch 61	0.897	18	0.000
School pop-per 500	-0.508	19	0.001
Lang prog	0.492	20	0.001
Sch 67	0.837	21	0.000
Sch 71	0.803	22	0.000
Absences Unexcused-per 10	-0.260	23	0.000
Operable Windows	0.249	24	0.000
(Constant)	8.022		
		Model R^2	**0.257**

a. Dependent Variable: MATHDELT

Table 11: Capistrano Math Daylight Order

Variable	B	**Order of Entry**	**Change in R^2**
Grade 2	9.611	1	0.149
Grade 3	5.837	2	0.064
32	61.504	3	0.007
Grade 4	1.804	4	0.006
48	-45.852	5	0.004
GATE prog	-1.235	6	0.003
45	-40.338	7	0.003
02	-33.927	8	0.002
18	35.609	9	0.002
Sch 72	-2.383	10	0.002
33	34.274	11	0.002
Window Code	0.372	12	0.001
Sch 60	-2.347	13	0.002
Sch 59	-1.898	14	0.001
Skylight Type A	2.556	15	0.001
School pop-per 500	-0.601	16	0.001
Absences Unverified-per 10	-2.534	17	0.001
Sch 74	-0.851	18	0.001
Operable Windows	0.835	19	0.001
Sch 62	1.312	20	0.001
Sch 82	1.207	21	0.001
Sch 85	-1.089	22	0.001
Absences Unexcused-per 10	-0.292	23	0.000
Sch 70	-1.265	24	0.000
Lang Prog	0.513	25	0.001
(Constant)	8.621		
		Model R^2	**0.258**

a. Dependent Variable: MATHDELT

Table 12: Capistrano Math Skylight Order

6.1.2 Seattle School District Tabular Results

Seattle Conversions	Reading	Math
Low score	1	1
High score	99	99
Range	98	98
Scalar to 1-99 scale	1	1
District Mean	57.35	58.82
Daylight Code Ranges	B-coefficient multiplier	
Daylight 1-5	4	4
Window 1-4.5	3.5	3.5
Skylight 0-4.5	4.5	4.5

Table 13: Seattle Conversion Factors

Window Code	Count Of Students	Daylight Code	Count Of Students	Skylight Code	Count Of Students
1.00	419	1.00	369	.00	7089
1.50	70	1.50	70	1.50	8
2.00	599	2.00	599	2.00	20
2.50	235	2.50	285	2.50	50
3.00	4674	3.00	4334	3.00	278
3.50	146	3.50	146	3.50	145
4.00	1363	4.00	1272	No Category	27
4.50	84	4.50	84		
No Category	27	5.00	431		
		No Category	27		
Grand Total	7617	Grand Total	7617	Grand Total	7617

Table 14: Count of Students by Daylight Code, Seattle

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Daylight Code	7590	1.000	5.000	3.053	.752
Window Code	7590	1.000	4.500	2.989	.734
Skylight Code	7590	.000	4.500	.212	.806
Class SF	7617	638.000	3616.000	1110.707	688.906
Open rm	7617	.000	1.000	.104	.306
Portable	7617	.000	1.000	.030	.171
School pop-per 500	7617	.088	.616	.381	.115
Vintage	7617	7.000	92.000	39.812	26.370
Econ 2	7617	.000	1.000	.405	.491
Ethnic 1	7617	.000	1.000	.066	.249
Ethnic 2	7617	.000	1.000	.214	.410
Ethnic 3	7617	.000	1.000	.021	.144
Ethnic 4	7617	.000	1.000	.227	.419
Gender	7614	.000	1.000	.512	.500
Gifted room (70%+)	7617	.000	1.000	.049	.216
Grade 2	7617	.000	1.000	.214	.410
Grade 3	7617	.000	1.000	.269	.444
Grade 4	7617	.000	1.000	.248	.432
Socio 1	7617	.000	1.000	.030	.172
Socio 2	7617	.000	1.000	.043	.202
Socio 3	7617	.000	1.000	.288	.453
Students per Class	7600	5.000	80.000	24.025	13.238
Reading NCE 98	7538	1.000	99.000	57.350	19.518
Valid N (listwise)	7491				

Table 15: Seattle Reading Descriptive Statistics

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Daylight Code	7590	1.000	5.000	3.053	.752
Window Code	7590	1.000	4.500	2.989	.734
Skylight Code	7590	.000	4.500	.212	.806
Class SF	7617	638.000	3616.000	1110.707	688.906
Open room	7617	.000	1.000	.104	.306
Portable	7617	.000	1.000	.030	.171
School pop-per 500	7617	.088	.616	.381	.115
Vintage	7617	7.000	92.000	39.812	26.370
Econ 2	7617	.000	1.000	.405	.491
Ethnic 1	7617	.000	1.000	.066	.249
Ethnic 2	7617	.000	1.000	.214	.410
Ethnic 3	7617	.000	1.000	.021	.144
Ethnic 4	7617	.000	1.000	.227	.419
Gender	7614	.000	1.000	.512	.500
Gifted room (70%+)	7617	.000	1.000	.049	.216
Grade 2	7617	.000	1.000	.214	.410
Grade 3	7617	.000	1.000	.269	.444
Grade 4	7617	.000	1.000	.248	.432
Socio 1	7617	.000	1.000	.030	.172
Socio 2	7617	.000	1.000	.043	.202
Socio 3	7617	.000	1.000	.288	.453
Students per Class	7600	5.000	80.000	24.025	13.238
Math NCE 98	7422	1.000	99.000	58.820	19.467
Valid N (listwise)	7379				

Table 16: Seattle Math Descriptive Statistics

Coefficients[a]

		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	54.667	1.726		31.672	.000
	Daylight Code	1.883	.342	.073	5.509	.000
	Class SF	-.002	.000	-.054	-3.427	.001
	Portable	-2.123	1.121	-.019	-1.893	.058
	School pop-per 500	6.662	1.762	.039	3.782	.000
	Econ 2	-8.675	.475	-.218	-18.253	.000
	Ethnic 1	-7.766	.797	-.099	-9.743	.000
	Ethnic 2	-8.461	.522	-.178	-16.214	.000
	Ethnic 3	-6.559	1.336	-.049	-4.908	.000
	Ethnic 4	-11.168	.557	-.238	-20.047	.000
	Gender	.912	.380	.023	2.398	.016
	Gifted room (70%+)	15.342	.894	.171	17.162	.000
	Grade 2	6.957	.596	.146	11.670	.000
	Grade 3	-2.074	.523	-.047	-3.966	.000
	Grade 4	.949	.529	.021	1.794	.073
	Socio 1	-4.481	1.131	-.039	-3.962	.000
	Socio 2	-3.182	1.011	-.033	-3.148	.002
	Socio 3	-2.618	.480	-.061	-5.449	.000
	Students per Class	.137	.025	.094	5.559	.000
	O07	-70.231	16.408	-.042	-4.280	.000
	O21	-65.215	16.413	-.039	-3.973	.000
	O26	-65.414	16.407	-.039	-3.987	.000
	O64	-67.927	16.409	-.040	-4.140	.000
	O73	-71.141	16.408	-.042	-4.336	.000

a. Dependent Variable: Reading NCE 98

Table 17: Seattle Reading Daylight Model R^2=0.297

Coefficients[a]

		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	52.910	1.828		28.938	.000
	Window Code	2.206	.374	.083	5.907	.000
	Skylight Code	.873	.239	.036	3.660	.000
	Class SF	-.001	.000	-.045	-2.731	.006
	Portable	-1.932	1.120	-.017	-1.724	.085
	School pop-per 500	7.268	1.766	.043	4.115	.000
	Econ 2	-8.657	.475	-.217	-18.242	.000
	Ethnic 2	-8.487	.521	-.179	-16.299	.000
	Ethnic 4	-11.167	.556	-.238	-20.090	.000
	Ethnic 1	-7.755	.796	-.099	-9.748	.000
	Ethnic 3	-6.570	1.334	-.049	-4.925	.000
	Gender	.919	.379	.024	2.422	.015
	Gifted room (70%+)	15.255	.899	.170	16.961	.000
	Grade 2	7.124	.597	.150	11.926	.000
	Grade 3	-1.991	.523	-.045	-3.809	.000
	Grade 4	.985	.528	.022	1.865	.062
	Socio 1	-4.358	1.129	-.038	-3.859	.000
	Socio 2	-3.051	1.009	-.031	-3.023	.003
	Socio 3	-2.543	.480	-.059	-5.303	.000
	Students per Class	.141	.024	.096	5.774	.000
	O07	-70.071	16.377	-.041	-4.279	.000
	O21	-65.146	16.382	-.039	-3.977	.000
	O26	-65.407	16.376	-.039	-3.994	.000
	O64	-67.774	16.377	-.040	-4.138	.000
	O73	-71.044	16.377	-.042	-4.338	.000
	O87	-63.627	16.380	-.038	-3.884	.000

a. Dependent Variable: Reading NCE 98

Table 18: Seattle Reading Skylight Model R^2=0.300

Coefficients[a]

		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	55.653	1.841		30.235	.000
	Daylight Code	1.391	.436	.054	3.190	.001
	Class SF	-.001	.001	-.037	-1.860	.063
	Open room	3.506	1.579	.056	2.220	.026
	Portable	-3.058	1.171	-.027	-2.611	.009
	School pop-per 500	11.522	2.065	.068	5.578	.000
	Vintage	.017	.010	.023	1.654	.098
	Econ 2	-5.790	.475	-.146	-12.193	.000
	Ethnic 1	-5.477	.803	-.070	-6.823	.000
	Ethnic 3	-6.978	1.381	-.051	-5.053	.000
	Ethnic 4	-11.452	.538	-.244	-21.272	.000
	Gender	-3.017	.392	-.077	-7.697	.000
	Gifted room (70%+)	16.394	.931	.185	17.614	.000
	Grade 2	6.104	.577	.129	10.571	.000
	Grade 3	-3.388	.477	-.077	-7.108	.000
	Socio 1	-4.339	1.167	-.038	-3.717	.000
	Socio 2	-4.691	1.057	-.048	-4.437	.000
	Socio 3	-3.107	.494	-.072	-6.291	.000
	Students per Class	.066	.033	.046	2.012	.044
	O06	54.400	16.802	.033	3.238	.001
	O23	58.049	16.824	.035	3.450	.001
	O43	-64.973	16.814	-.039	-3.864	.000

a. Dependent Variable: Math NCE 98

Table 19: Seattle Math Daylight Model R^2=0.258

Coefficients[a]

		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	51.877	1.751		29.620	.000
	Window Code	2.474	.376	.094	6.585	.000
	Skylight Code	.762	.245	.032	3.105	.002
	Open room	2.918	1.333	.046	2.188	.029
	Portable	-2.394	1.153	-.021	-2.076	.038
	School pop-per 500	10.869	1.904	.064	5.708	.000
	Econ 2	-5.793	.473	-.146	-12.242	.000
	Ethnic 1	-5.443	.801	-.070	-6.799	.000
	Ethnic 3	-6.991	1.378	-.051	-5.075	.000
	Ethnic 4	-11.526	.536	-.246	-21.489	.000
	Gender	-3.027	.391	-.078	-7.739	.000
	Gifted room (70%+)	16.384	.937	.185	17.484	.000
	Grade 2	6.305	.573	.133	11.012	.000
	Grade 3	-3.299	.475	-.075	-6.939	.000
	Socio 1	-4.223	1.165	-.037	-3.627	.000
	Socio 2	-4.562	1.054	-.046	-4.327	.000
	Socio 3	-3.062	.493	-.071	-6.212	.000
	Students per Class	.074	.032	.051	2.347	.019
	O06	54.540	16.762	.033	3.254	.001
	O23	56.990	16.802	.034	3.392	.001
	O32	55.008	16.761	.033	3.282	.001
	O43	-65.073	16.773	-.039	-3.880	.000
	O88	53.850	16.757	.032	3.214	.001

a. Dependent Variable: Math NCE 98

Table 20: Seattle Math Skylight Model R^2=0.262

VARIABLE:	B	**Order of Entry**	**Change in R^2**
Econ 2	-8.675	1	0.165
Gifted room (70%+)	15.342	2	0.035
Ethnic 4	-11.168	3	0.024
Ethnic 2	-8.461	4	0.021
Grade 2	6.957	5	0.017
Ethnic 1	-7.766	6	0.008
Grade 3	-2.074	7	0.004
Ethnic 3	-6.559	8	0.003
Students pop-per 500	6.662	9	0.002
Daylight Code	1.883	10	0.003
Students per Class	0.137	11	0.002
Socio 3	-2.618	12	0.002
73	-71.141	13	0.002
07	-70.231	14	0.002
64	-67.927	15	0.002
21	-65.215	16	0.002
26	-65.414	17	0.001
Socio 1	-4.481	18	0.001
Class SF	-0.002	19	0.001
Socio 2	-3.182	20	0.001
Gender	0.912	21	0.001
Portable	-2.123	22	0.000
Grade 4	0.949	23	0.000
(Constant)	54.667		
		Model R^2	**0.297**

a. Dependent Variable: Reading NCE 98

Table 21: Seattle Reading Daylight Order

VARIABLE	B	Order of Entry	Change in R^2
Econ 2	-8.657	1	0.165
Gifted room (70%+)	15.255	2	0.035
Ethnic 4	-11.167	3	0.024
Ethnic 2	-8.487	4	0.021
Grade 2	7.124	5	0.017
Ethnic 1	-7.755	6	0.008
Grade 3	-1.991	7	0.004
Ethnic 3	-6.570	8	0.003
Window Code	2.206	9	0.002
Students per Class	0.141	10	0.003
Students pop-per 500	7.268	11	0.002
Socio 3	-2.543	12	0.002
73	-71.044	13	0.002
07	-70.071	14	0.002
64	-67.774	15	0.002
21	-65.146	16	0.002
26	-65.407	17	0.002
87	-63.627	18	0.001
Skylight Code	0.873	19	0.001
Socio 1	-4.358	20	0.001
Socio 2	-3.051	21	0.001
Class SF	-0.001	22	0.001
Gender	0.919	23	0.001
Grade 4	0.985	24	0.000
Portable	-1.932	25	0.000
(Constant)	52.910		
		Model R^2	**0.300**

a. Dependent Variable: Reading NCE 98

Table 22: Seattle Reading Skylight Order

Variable	B	**Order of Entry**	**Change in R^2**
Ethnic 4	-11.452	1	0.117
Gifted room (70%+)	16.394	2	0.048
Econ 2	-5.790	3	0.037
Grade 2	6.104	4	0.020
Gender	-3.017	5	0.005
Grade 3	-3.388	6	0.005
Ethnic 1	-5.477	7	0.004
Students pop-per 500	11.522	8	0.004
Ethnic 3	-6.978	9	0.003
Socio 3	-3.107	10	0.002
Socio 2	-4.691	11	0.002
Socio 1	-4.339	12	0.001
43	-64.973	13	0.001
23	58.049	14	0.001
Vintage	0.017	15	0.001
Open room	3.506	16	0.001
Daylight Code	1.391	17	0.001
06	54.400	18	0.001
Portable	-3.058	19	0.001
Students per Class	0.066	20	0.000
Class SF	-0.001	21	0.000
(Constant)	55.653		
		Model R^2	**0.258**

a. Dependent Variable: Math NCE 98

Table 23: Seattle Math Daylight Order

Variable	B	Order of Entry	Change in R^2
Ethnic 4	-11.526	1	0.117
Gifted room (70%+)	16.384	2	0.048
Econ 2	-5.793	3	0.037
Grade 2	6.305	4	0.020
Gender	-3.027	5	0.005
Grade 3	-3.299	6	0.005
Ethnic 1	-5.443	7	0.004
Students pop-per 500	10.869	8	0.004
Ethnic 3	-6.991	9	0.003
Socio 3	-3.062	10	0.002
Socio 2	-4.562	11	0.002
Socio 1	-4.223	12	0.001
43	-65.073	13	0.001
23	56.990	14	0.001
32	55.008	15	0.001
88	53.850	16	0.001
06	54.540	17	0.001
Skylight Code	0.762	18	0.001
Window Code	2.474	19	0.001
Open room	2.918	20	0.004
Students per Class	0.074	21	0.001
Portable	-2.394	22	0.000
(Constant)	51.877		
		Model R^2	**0.262**

a. Dependent Variable: Math NCE 98

Table 24: Seattle Math Skylight Order

6.1.3 Fort Collins School District Tabular Results

Fort Collins Conversions	**reading**	**math**
High score	257	280
Low score	153	153
Range	104	127
Scalar to 1-99 scale	0.94	0.77
District Mean	213.39	219.41
Min to Mean	60.39	66.41
Normalized Mean	56.91	51.24
Daylight Code Ranges	B-coefficient multiplier	
Daylight 1-5	4	4
Window 0-3	3	3
Skylight yes-no	1	1

Table 25: Fort Collins Conversion Factors

Window Code	Number of Students	Daylight Code	Number of Students	Skylight Code	Number of Students
1	2092	1	2092	0	4027
2	3652	2	1106	1	2239
3	522	3	829		
		5	2239		
Grand Total	6266	Grand Total	6266	Grand Total	6266

Table 26: Count of Students by Daylight Code, Fort Collins

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Daylight Code	5204	1.000	5.000	2.893	1.715
Window Code	5204	1.000	3.000	1.752	.592
Skylight Code (0,1)	5204	.000	1.000	.364	.481
Open Rm	5204	.000	1.000	.314	.464
School Pop-per 500	5204	.233	.779	.603	.125
Vintage	5204	5.000	62.000	24.315	14.478
Econ 1	5204	.000	1.000	.146	.353
Econ 2	5204	.000	1.000	.061	.239
Ethnic 1	5204	.000	1.000	.091	.288
Ethnic 2	5204	.000	1.000	.028	.166
Ethnic 3	5204	.000	1.000	.008	.091
Ethnic 4	5204	.000	1.000	.012	.110
Gender	5204	.000	1.000	.527	.499
Grade 3	5204	.000	1.000	.226	.418
Grade 4	5204	.000	1.000	.244	.429
Grade 5	5204	.000	1.000	.261	.439
Lang Prog	5204	.000	1.000	.094	.292
Socio 1	5204	.000	1.000	.033	.179
Socio 2	5204	.000	1.000	.012	.107
Socio 3	5204	.000	1.000	.192	.394
Reading RIT	5203	153.000	257.000	213.390	13.708
Valid N (listwise)	5203				

Table 27: Fort Collins Reading Descriptive Statistics

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Daylight Code	5688	1.000	5.000	2.802	1.708
Window Code	5688	1.000	3.000	1.727	.596
Skylight Code (0,1)	5688	.000	1.000	.342	.475
Open rm	5688	.000	1.000	.335	.472
School Pop-per 500 students	5688	.233	.779	.609	.124
Vintage	5688	5.000	62.000	25.040	14.783
Econ 1	5688	.000	1.000	.150	.357
Econ 2	5688	.000	1.000	.062	.241
Ethnic 1	5688	.000	1.000	.091	.288
Ethnic 2	5688	.000	1.000	.027	.161
Ethnic 3	5688	.000	1.000	.009	.093
Ethnic 4	5688	.000	1.000	.012	.111
Gender	5688	.000	1.000	.521	.500
Grade 3	5688	.000	1.000	.233	.423
Grade 4	5688	.000	1.000	.254	.435
Grade 5	5688	.000	1.000	.256	.436
Lang prog	5688	.000	1.000	.094	.291
Socio 1	5688	.000	1.000	.034	.181
Socio 2	5688	.000	1.000	.013	.112
Socio 3	5688	.000	1.000	.195	.396
Math RIT	5687	153.000	280.000	219.406	15.481
Valid N (listwise)	5687				

Table 28: Fort Collins Math Descriptive Statistics

Coefficients[a]

		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	222.462	.908		244.989	.000
	Daylight Code	.996	.148	.125	6.736	.000
	Open Rm	2.911	.544	.099	5.348	.000
	School Pop-per 500	-4.532	1.420	-.041	-3.192	.001
	Econ 1	-7.070	.470	-.182	-15.046	.000
	Econ 2	-4.823	.648	-.084	-7.440	.000
	Ethnic 1	-5.515	.587	-.116	-9.400	.000
	Ethnic 3	-5.171	1.682	-.034	-3.075	.002
	Ethnic 4	-2.769	1.382	-.022	-2.003	.045
	Gender	.918	.304	.033	3.016	.003
	Grade 3	-18.728	.434	-.572	-43.115	.000
	Grade 4	-11.864	.426	-.372	-27.875	.000
	Grade 5	-4.555	.417	-.146	-10.925	.000
	Lang Prog	-1.846	.565	-.039	-3.268	.001
	Socio 1	-2.877	.851	-.038	-3.379	.001
	Socio 2	-3.354	1.426	-.026	-2.352	.019
	O07	-52.627	10.933	-.053	-4.813	.000
	O26	-62.162	10.951	-.063	-5.676	.000
	O38	-57.764	10.948	-.058	-5.276	.000
	O55	-56.895	10.948	-.058	-5.197	.000
	O84	-51.415	10.934	-.052	-4.702	.000
	O88	-52.769	10.944	-.053	-4.822	.000
	O91	-49.545	10.933	-.050	-4.532	.000
	O107	-64.113	10.934	-.065	-5.864	.000

a. Dependent Variable: Reading RIT

Table 29: Fort Collins Reading Daylight Model R^2=0.368

Coefficients[a]

		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	218.087	1.121		194.565	.000
	Window Code	3.612	.556	.156	6.493	.000
	Open Rm	4.043	.695	.137	5.817	.000
	Vintage	-.087	.012	-.092	-7.510	.000
	Econ 1	-6.985	.459	-.180	-15.213	.000
	Econ 2	-4.828	.645	-.084	-7.485	.000
	Ethnic 1	-5.282	.584	-.111	-9.050	.000
	Ethnic 3	-5.334	1.678	-.035	-3.179	.001
	Ethnic 4	-2.839	1.378	-.023	-2.060	.039
	Gender	.935	.304	.034	3.080	.002
	Grade 3	-18.947	.435	-.578	-43.513	.000
	Grade 4	-11.977	.426	-.375	-28.113	.000
	Grade 5	-4.532	.416	-.145	-10.896	.000
	Lang Prog	-2.044	.565	-.044	-3.620	.000
	Socio 1	-2.770	.848	-.036	-3.265	.001
	Socio 2	-3.246	1.422	-.025	-2.282	.023
	O07	-52.811	10.907	-.053	-4.842	.000
	O107	-63.946	10.907	-.065	-5.863	.000
	O26	-63.875	10.933	-.065	-5.843	.000
	O38	-58.613	10.928	-.059	-5.364	.000
	O55	-58.245	10.926	-.059	-5.331	.000
	O84	-51.598	10.907	-.052	-4.731	.000
	O88	-51.613	10.915	-.052	-4.729	.000
	O91	-49.746	10.907	-.050	-4.561	.000

a. Dependent Variable: Reading RIT

Table 30: Fort Collins Reading Skylight Model R^2=0.371

Coefficients[a]

		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	233.088	.928		251.288	.000
	Daylight Code	1.112	.151	.123	7.350	.000
	Open rm	3.955	.552	.121	7.172	.000
	School Pop-per 500	-5.288	1.451	-.042	-3.645	.000
	Econ 1	-6.534	.499	-.151	-13.107	.000
	Econ 2	-3.328	.658	-.052	-5.058	.000
	Ethnic 1	-6.172	.562	-.115	-10.987	.000
	Ethnic 2	3.650	.966	.038	3.778	.000
	Ethnic 3	-5.346	1.660	-.032	-3.220	.001
	Ethnic 4	-4.725	1.393	-.034	-3.392	.001
	Gender	-1.755	.309	-.057	-5.679	.000
	Grade 3	-24.269	.441	-.664	-55.009	.000
	Grade 4	-16.537	.432	-.465	-38.324	.000
	Grade 5	-7.511	.431	-.212	-17.440	.000
	Socio 1	-4.122	.864	-.048	-4.771	.000
	Socio 2	-6.566	1.391	-.047	-4.721	.000
	Socio 3	-1.329	.424	-.034	-3.132	.002
	O08	42.142	11.615	.036	3.628	.000
	O09	-42.790	11.630	-.037	-3.679	.000
	O25	44.084	11.653	.038	3.783	.000
	O30	45.724	11.615	.039	3.936	.000
	O53	49.234	11.615	.042	4.239	.000
	O60	44.951	11.615	.039	3.870	.000
	O72	47.595	11.653	.041	4.084	.000
	O95	-54.002	11.616	-.046	-4.649	.000
	O195	44.247	11.613	.038	3.810	.000

a. Dependent Variable: Math RIT

Table 31: Fort Collins Math Daylight Model R^2=0.439

Coefficients[a]

		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	229.594	1.690		135.883	.000
	Skylight Code (0,1)	2.082	.710	.064	2.935	.003
	Window Code	3.043	.597	.117	5.095	.000
	Open rm	5.182	.764	.158	6.800	.000
	School Pop-per 500 students	-3.048	1.580	-.025	-1.946	.052
	Vintage	-.037	.019	-.035	-1.962	.050
	Econ 1	-6.547	.502	-.151	-13.081	.000
	Econ 2	-3.320	.663	-.052	-5.030	.000
	Ethnic 1	-6.211	.565	-.116	-11.010	.000
	Ethnic 2	3.617	.972	.038	3.726	.000
	Ethnic 3	-5.465	1.671	-.033	-3.276	.001
	Ethnic 4	-4.873	1.402	-.035	-3.483	.001
	Gender	-1.799	.311	-.058	-5.757	.000
	Grade 3	-24.525	.445	-.670	-55.112	.000
	Grade 4	-16.752	.436	-.471	-38.481	.000
	Grade 5	-7.563	.433	-.213	-17.432	.000
	Socio 1	-4.113	.869	-.048	-4.731	.000
	Socio 2	-6.502	1.400	-.047	-4.644	.000
	Socio 3	-1.462	.427	-.037	-3.424	.001
	O29	-69.629	11.689	-.060	-5.964	.000
	O53	47.883	11.699	.041	4.099	.000
	O72	47.311	11.728	.041	4.038	.000
	O95	-55.410	11.698	-.047	-4.739	.000

a. Dependent Variable: Math RIT

Table 32: Fort Collins Math Skylight Model R^2=0.434

Variable	B	Order of Entry	Change in R^2
Grade 3	-18.728	1	0.162
Grade 4	-11.864	2	0.081
Econ 1	-7.070	3	0.047
Ethnic 1	-5.515	4	0.017
Grade 5	-4.555	5	0.014
Students pop-per 500	-4.532	6	0.008
Econ 2	-4.823	6	0.008
107	-64.113	7	0.004
26	-62.162	8	0.004
38	-57.764	9	0.004
55	-56.895	10	0.004
84	-51.415	11	0.003
07	-52.627	12	0.003
88	-52.769	13	0.003
91	-49.545	14	0.002
Daylight Code	0.996	15	0.002
Open Room	2.911	16	0.002
Ethnic 3	-5.171	17	0.001
Lang prog	-1.846	18	0.001
Socio 1	-2.877	19	0.001
Gender	0.918	21	0.001
Socio 2	-3.354	22	0.001
Ethnic 4	-2.769	23	0.000
(Constant)	222.462	.	.
		Model R^2	**0.374**

a. Dependent Variable: Reading RIT

Table 33: Fort Collins Reading Daylight Order

Variable	B	Order of Entry	Change in R^2
Grade 3	-18.947	1	0.162
Grade 4	-11.977	2	0.081
Econ 1	-6.985	3	0.047
Ethnic 1	-5.282	4	0.017
Grade 5	-4.532	5	0.014
Econ 2	-4.828	6	0.008
107	-63.946	7	0.004
26	-63.875	8	0.004
Vintage	-0.087	9	0.004
38	-58.613	10	0.003
55	-58.245	11	0.003
07	-52.811	12	0.003
84	-51.598	13	0.003
88	-51.613	14	0.003
91	-49.746	15	0.002
Ethnic 3	-5.334	16	0.001
Socio 1	-2.770	17	0.001
Lang prog	-2.044	18	0.001
Gender	0.935	19	0.001
Window Code	3.612	20	0.001
Open Room	4.043	21	0.004
Socio 2	-3.246	22	0.001
Ethnic 4	-2.839	23	0.001
(Constant)	218.087		
		Model R^2	**0.371**

a. Dependent Variable: Reading RIT

Table 34: Fort Collins Reading Skylight Order

Variable	B	Order of Entry	Change in R^2
Grade 3	-24.269	1	0.200
Grade 4	-16.537	2	0.118
Econ 1	-6.534	3	0.041
Grade 5	-7.511	4	0.029
Ethnic 1	-6.172	5	0.014
Econ 2	-3.328	6	0.004
Gender	-1.755	7	0.003
Ethnic 2	3.650	8	0.003
95	-54.002	9	0.002
Socio 2	-6.566	10	0.002
Socio 1	-4.122	11	0.002
53	49.234	12	0.002
30	45.724	13	0.002
95	44.247	14	0.002
72	47.595	15	0.001
08	42.142	16	0.001
60	44.951	17	0.001
09	-42.790	18	0.001
25	44.084	19	0.001
Ethnic 3	-5.346	20	0.001
Ethnic 4	-4.725	21	0.001
Socio 3	-1.329	22	0.001
Daylight Code	1.112	23	0.001
Open Room	3.955	24	0.004
School pop-per 500	-5.288	25	0.001
(Constant)	233.088		
		Model R^2	**0.439**

a. Dependent Variable: Math RIT

Table 35: Fort Collins Math Daylight Order

Variable	B	Order of Entry	Change in R^2
Grade 3	-24.525	1	0.199
Grade 4	-16.752	2	0.117
Econ 1	-6.547	3	0.041
Grade 5	-7.563	4	0.029
Ethnic 1	-6.211	5	0.014
Econ 2	-3.320	6	0.004
29	-69.629	7	0.004
Gender	-1.799	8	0.003
Ethnic 2	3.617	9	0.003
Vintage	-0.037	10	0.003
95	-55.410	11	0.002
53	47.883	12	0.002
Socio 2	-6.502	13	0.002
Socio 1	-4.113	14	0.002
72	47.311	15	0.002
Socio 3	-1.462	16	0.001
Ethnic 4	-4.873	17	0.001
Ethnic 3	-5.465	18	0.001
Open Room	5.182	19	0.000
Window Code	3.043	20	0.004
Skylight Code (0,1)	2.082	21	0.001
School pop-per 500	-3.048	22	0.000
(Constant)	229.594		.
		Model R^2	**0.434**

a. Dependent Variable: Math RIT

Table 36: Fort Collins Math Skylight Order

6.2 Report on Classroom-level Analysis for Capistrano

This memo reports the added classroom level analysis, as suggested by Bob Clear at the LBNL review on June 3rd. The main results are the classroom-level analysis of the math and reading skylighting models for Capistrano schools. The correlations between the skylight, window and daylighting variables relative to grade level are also reported.

Summary of Classroom-Level Models

The following table compares the results of the classroom level analysis with the original student level analysis. The table shows the regression output for the Skylight Type A explanatory variable for the math and reading models.

Math	B	Std Err	t	Sig
Student Level	2.556	0.469	5.449	0.000
Class Level	2.451	0.830	2.953	0.003
Reading	B	Std Err	t	Sig
Student Level	1.668	0.560	2.979	0.003
Class Level	1.932	0.728	2.655	0.008

Appendix Figure 1: Classroom vs. Student Level Results

The following points are important:

- The coefficient remained stable. The math coefficient dropped slightly but the reading coefficient rose a fair amount. Neither change was statistically significant.
- The standard errors increased as we expected.
- The t-statistics fell and the significance levels became somewhat poorer. But both variables are still highly significant.

As might be expected, the R-square statistic was much higher at the class level. The math model explained 67% of the variance at the class level. The reading model explained 47% of the variance at the class level. This illustrates the fact that the R-square statistic is strongly affected by the level of aggregation.

We did not repeat the analysis of the daylight models but we would expect the results to be similar.

In developing the classroom analysis, we estimated the components of variance associated with common classroom factors and student-specific factors.

In the case of math performance, the classroom component of the variance was about 20% of the total variance, while the student component of the variance was about 80%. In the case of the reading model, we found no classroom component of variance. We may postulate that the classroom effects are associated with differences between teachers. In this case, these results suggest that teachers are equally good at teaching reading but vary in their ability to teach math. More details are in the section on methodology that follows.

Correlations with Grade

We also calculated the Pearson correlation coefficients between student grade and the various skylighting and daylighting variables used in the models. We did this analysis at the student level. The table below shows the results. The correlations range from 0.01 to 0.06, on a potential scale of 0.0 to 1.0, i.e. they are all quite small. Some of the correlations are statistically significant, but this must be qualified by two observations. First, as usual, the sample size is very large, 8,268 students, increasing the probability for achieving statistical significance even for very small effects. Second, the skylighting variables are indicator variables so they do not satisfy the usual assumptions behind the Pearson test of significance.

It should be noted that our models did include indicator variables for grade so the models adjust for the correlation between grade and skylighting or daylighting. While we could attempt to estimate a model with interaction between these variables, we doubt that the sample would support the analysis.

Skylight Type AA	-0.035
Skylight Type A	-0.059
Skylight Type B	0.034
Skylight Type C	0.016
Skylight Type D	-0.013
Daylight_revised	0.047
Window_revised	-0.022

Appendix Figure 2: Skylight Model Pearson Correlations

Math Skylight Model – Class Level

The following table shows the full class-level model for math performance. The original student-level model was shown in Table 8 of the appendix to the report. With the exception of the indicators for the outliers, we have used exactly the same explanatory variables as the original student-level model so that the two models can be directly compared. The coefficients (B) are generally very similar as one would expect. Also, as expected, the significance levels (sig.) are generally numerically larger. In fact several of the explanatory variables are no longer significant and could be dropped from the model. Of course this would not change the main conclusion that the Type A skylighting variable remains highly significant with this classroom-level of analysis.

Coefficients[a]

		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	8.019	.888		9.027	.000
	Window Code	.399	.136	.103	2.943	.003
	Skylight Type A	2.451	.830	.133	2.953	.003
	Operable Windows	.915	.333	.103	2.745	.006
	School Pop-per 500	-.337	.350	-.033	-.963	.336
	GATE Prog	-.161	.760	-.007	-.212	.832
	Lang Prog	1.453	.985	.063	1.475	.141
	Absences Unv per 10	-11.159	5.536	-.068	-2.016	.045
	Absences Unexc per 10	-.263	.896	-.010	-.294	.769
	Grade 2	9.417	.409	.953	23.048	.000
	Grade 3	5.533	.412	.549	13.439	.000
	Grade 4	1.699	.421	.157	4.037	.000
	SCH59	-1.872	.779	-.074	-2.403	.017
	SCH60	-2.464	.680	-.116	-3.623	.000
	SCH62	1.745	.715	.081	2.440	.015
	SCH70	-2.353	1.003	-.098	-2.346	.019
	SCH72	-2.588	.666	-.147	-3.885	.000
	SCH74	-.477	.676	-.022	-.706	.481
	SCH82	1.625	.651	.081	2.498	.013
	SCH85	-.777	.786	-.042	-.988	.324

a. Dependent Variable: MATHDEL_

Appendix Figure 3: Math Skylight Model - Classroom-level Results

Reading Skylight Model – Class Level

The following table shows the full class-level model for reading performance. The original student-level model was shown in Table 6 of the appendix to the report. Again this is very similar to the original student-level model. Again, the significance levels (sig.) are generally numerically larger. In fact several of the explanatory variables are no longer significant and could be dropped from the model. In particular, the Type B skylighting variable has become insignificant.

Coefficients[a]

		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	2.152	.493		4.368	.000
	Window Code	.453	.131	.181	3.458	.001
	Skylight Type A	1.932	.728	.166	2.655	.008
	Skylight Type AA	.550	.640	.035	.860	.390
	Skylight Type B	.056	1.354	.004	.041	.967
	Operable Windows	.981	.315	.184	3.114	.002
	School Pop-per 500	.295	.314	.077	.939	.348
	Gender	2.204	1.005	.158	2.194	.029
	GATE Prog	.693	.645	.046	1.073	.284
	Lang Prog	.445	.775	.026	.574	.566
	Grade 2	8.504	.533	.829	15.944	.000
	Grade 3	3.328	.342	.474	9.744	.000
	Grade 4	.964	.300	.161	3.210	.001
	SCH60	-1.260	.596	-.090	-2.116	.035
	SCH61	.850	.543	.068	1.566	.118
	SCH62	1.619	.642	.106	2.521	.012
	SCH64	1.767	1.129	.065	1.566	.118
	SCH66	-.361	.831	-.019	-.434	.665
	SCH67	.716	.554	.055	1.292	.197
	SCH72	-1.311	.541	-.116	-2.421	.016
	SCH77	.660	.538	.050	1.227	.221
	SCH81	.962	1.217	.074	.791	.430
	SCH82	1.457	.562	.109	2.591	.010
	SCH85	-1.057	.683	-.092	-1.549	.122
	SCH173	1.387	.700	.080	1.983	.048

a. Dependent Variable: READDEL_

Methodology

We created a new analysis database at the class level by calculating the average of the dependent and explanatory variables of each model within each classroom. For example, the number of absences was calculated as the classroom average value of the absences of each student. In the case of an indicator variable, the average is identical to the fraction of students in the classroom. For example, since Gate_N was an indicator variable in the original model, its average value is the fraction of the students in the classroom that are in the Gate program. The same is true for the gender and the grade indicators. In the case of any class-level variable, such as the skylighting indicators, we simply used the value for the class.

We excluded the students that had earlier been identified as outliers in the student level analysis. Dropping a student from the database is essentially equivalent to including an indicator variable for the student-level analysis. We also calculated the number of students in each class and the residual standard deviation of the original student-level models.

We used weighted least squares to fit the models. We used a maximum likelihood estimation methodology to identify the most appropriate model for the residual variance of the classroom-level models. We postulated a variance-component model for the student-level model. Specifically we assumed that the random component of the test performance of each student is the sum of a classroom-specific effect that is common to all students in a given classroom, and a student-specific effect. We can write this as:

$$e_{ij} = d_j + h_{ij}$$

Here the following notation is used

$e_{ij} =$ random error in student-level model, representing the random deviation of student *i*'s performance from the expected value given the explanatory variables.

$d_j =$ common random component of variance for all students in classroom *j*, representing teacher and other classroom effects.

$h_{ij} =$ student-specific component of variance for each student *i* in classroom *j*:

We assume that d_j and h_{ij} are statistically independent, that d_j are identically distributed, that h_{ij} are identically distributed for all students *i* from each classroom ***j,***
that $E(d_j) = 0$, and $E(h_{ij}) = 0$. Using the usual notation for the mean of all students from each classroom, we have

$$Var(e_{ij}) = Var(d_j) + \frac{Var(h_{ij})}{n_j}$$

Here n_j denotes the number of students in class ***j***. Now we used the within-class residual variance of the student level models to estimate $s_j^2 = Var(h_{ij})$ and we used maximum likelihood methods to estimate $t^2 = Var(e_{ij})$.

In the case of the math model, we found that the maximum likelihood estimate of t^2 was about 0.25. By contrast the average value of $s_j^2 = Var(h_{ij})$ across all classrooms was about 1.0. This suggests that in the case of math performance, the classroom component of the variance was about 20% of the total variance, while the student component of the variance was about 80%. In the case of the reading model, we found that the maximum likelihood estimate of t^2 was 0. In other words, we found no classroom component of variance. We may postulate that the classroom effects are associated with differences between teachers. In this case, these results suggest that Capistrano teachers are quite uniform in their ability to teach reading, but vary in their ability to teach math. Alternatively, classroom effects may be a function of grouping students into classrooms by abilities. It may be that the district is more likely to assign students to a given classroom based on their math ability, but actively does not track children into classrooms based on their reading ability.

6.3 Sample Illumination Readings

6.4 Classroom Plans and Sections

6.5 Photographs of Schools and Classrooms

Illumination Readings

Capistrano, Skylight Type A, under bright sun, mid day, no electric lights

Dotted areas show **diffusing** 6’ x 6’ skylight and 14’ x 14’ skylight well

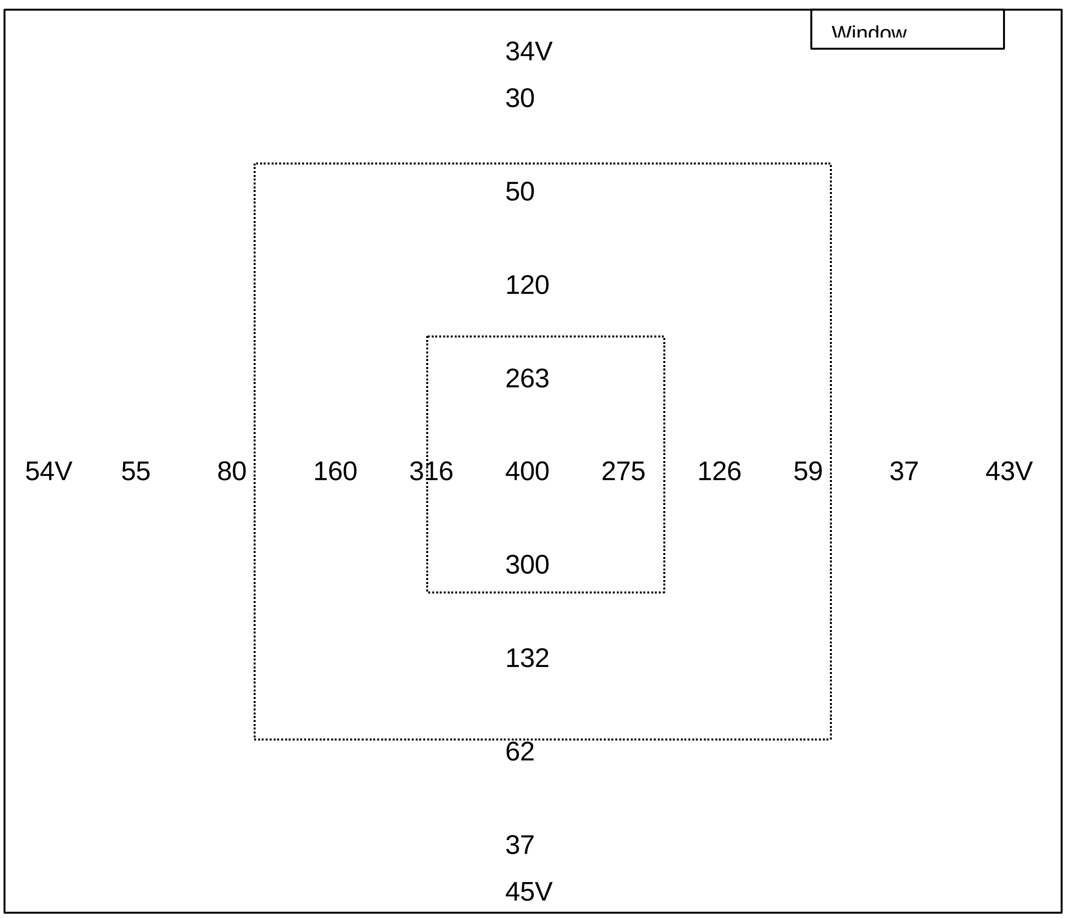
Window Code 1, Skylight Type A, Daylight Code 5

(This is brightest room measured. More typical is illumination peak of 250fc.)

All measurement in footcandles. V = vertical measurement at 5’0’

All other measurements horizontal at desk height = 26”+/- for elementary school

Classroom 30’ x 30’ August 98



Capistrano, Skylight Type A, under bright sun, mid day, **Louvers Closed**

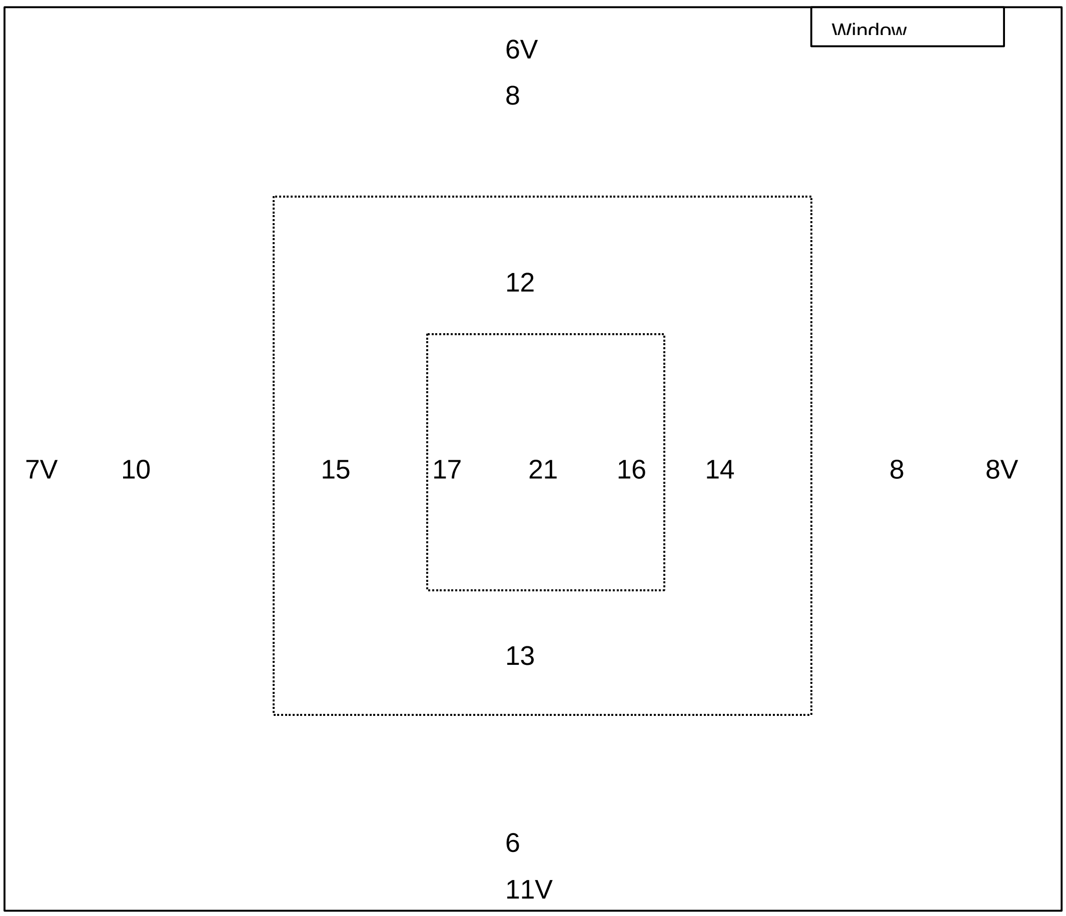
Dotted areas show diffusing 6' x 6' skylight and 14' x 14' skylight well

Window Code 1, Skylight Type A, Daylight Code 5

All measurement in footcandles. V = vertical measurement at 5'0'

All other measurements at desk height = 26"+/- for elementary school

Classroom 30' x 30' August 98



Capistrano, Skylight Type B, light overcast, 3PM, no electric lights

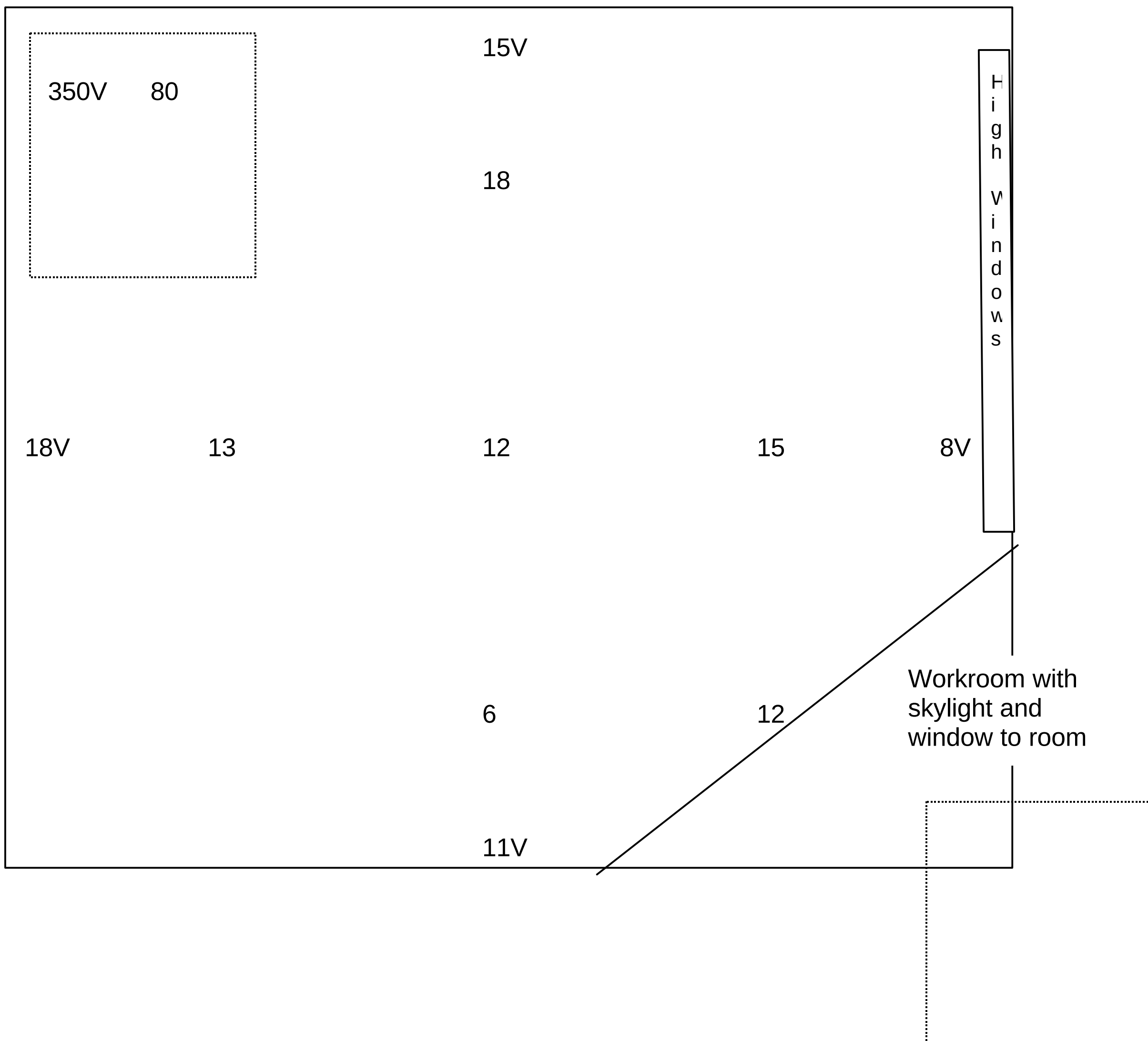
Dotted areas show 6’ x 6’ **clear** skylight (square of sunlight on northeast corner)

Window Code 2, Skylight Type B, Daylight Code 4

All measurement in footcandles. V = vertical measurement at 5’0’

All other measurements horizontal at desk height = 26”+/- for elementary school

Classroom 30’ x 30’ August 98



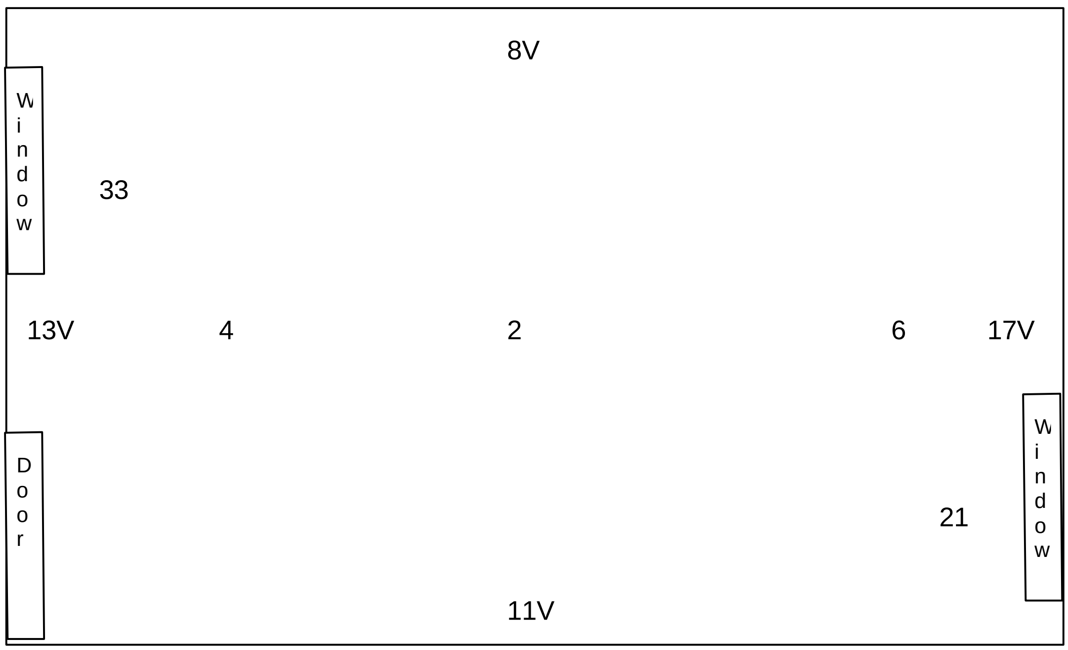
Capistrano, Portable, bright sun, 2PM, no electric lights, **door closed**

Window Code 1, Daylight Code 2

All measurement in footcandles. V = vertical measurement at 5'0'

All other measurements at desk height = 26"+/- for elementary school

Classroom 24' x 40' August 98



Capistrano, Portable, bright sun, 2PM, no electric lights, **door opened**

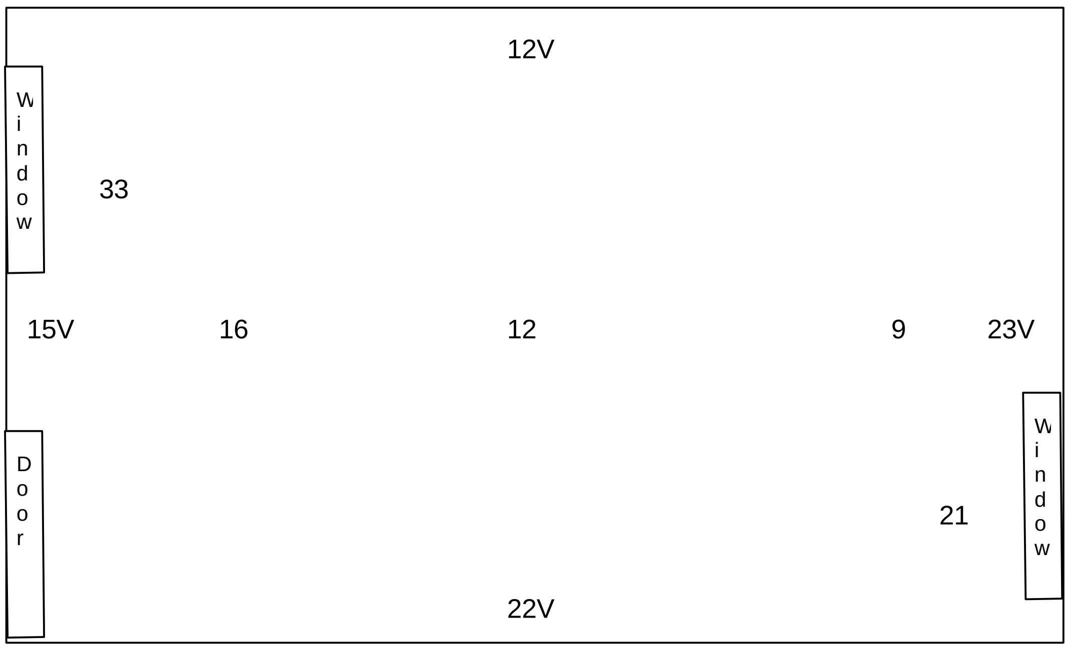
Window Code 1, Daylight Code 2

(Sunlight reflected off of entry porch and floor at doorway)

All measurement in footcandles. V = vertical measurement at 5'0'

All other measurements at desk height = 26"+/- for elementary school

Classroom 24' x 40' August 98



Capistrano, Modular Classroom, bright sun, 11AM, no electric lights

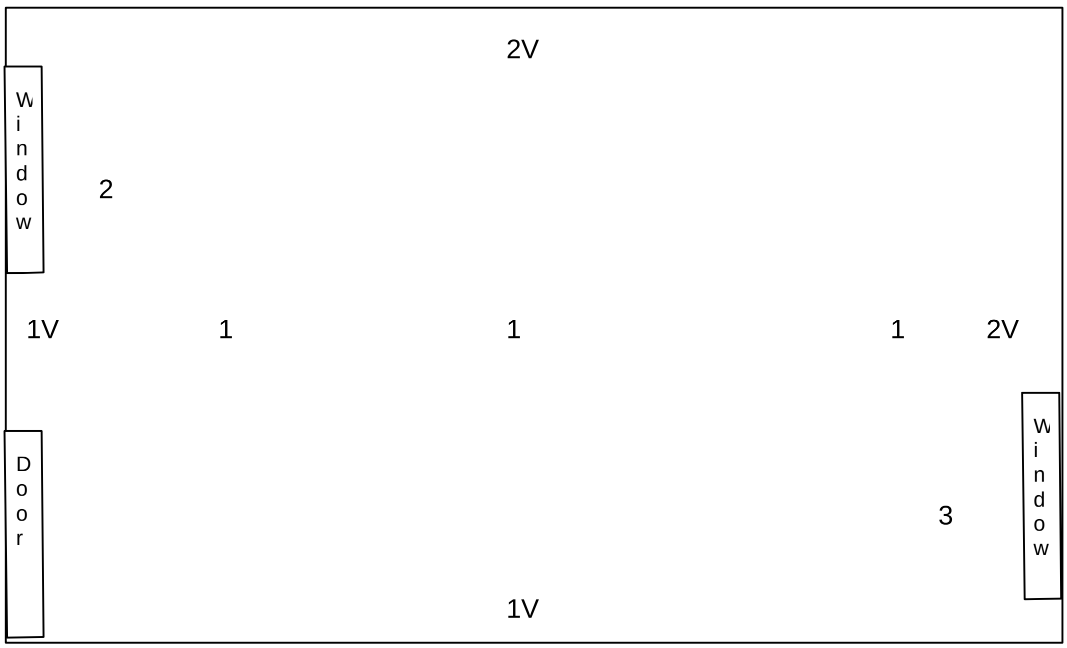
12% transmission glass, overhangs at walkway

Window Code 1, Daylight Code 1

All measurement in footcandles. V = vertical measurement at 5'0'

All other measurements at desk height = 26"+/- for elementary school

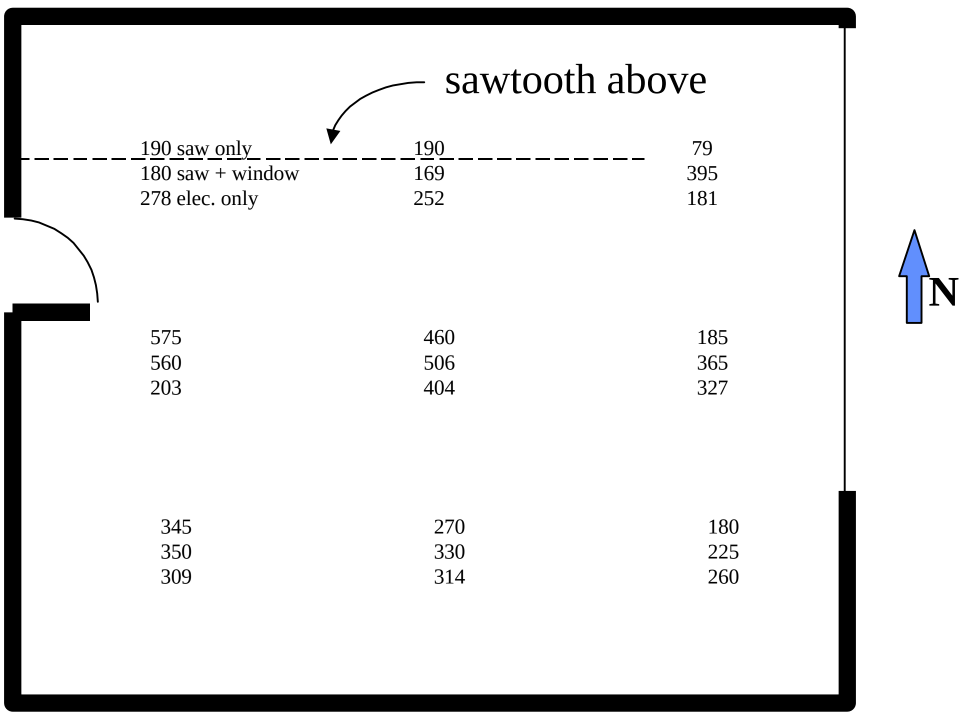
Classroom 24' x 40' August 98



Dunlap: new addition, room 6

light measurements in lux
horiz. @ about 30”
exterior illum. partly cloudy 24000-29000 lux

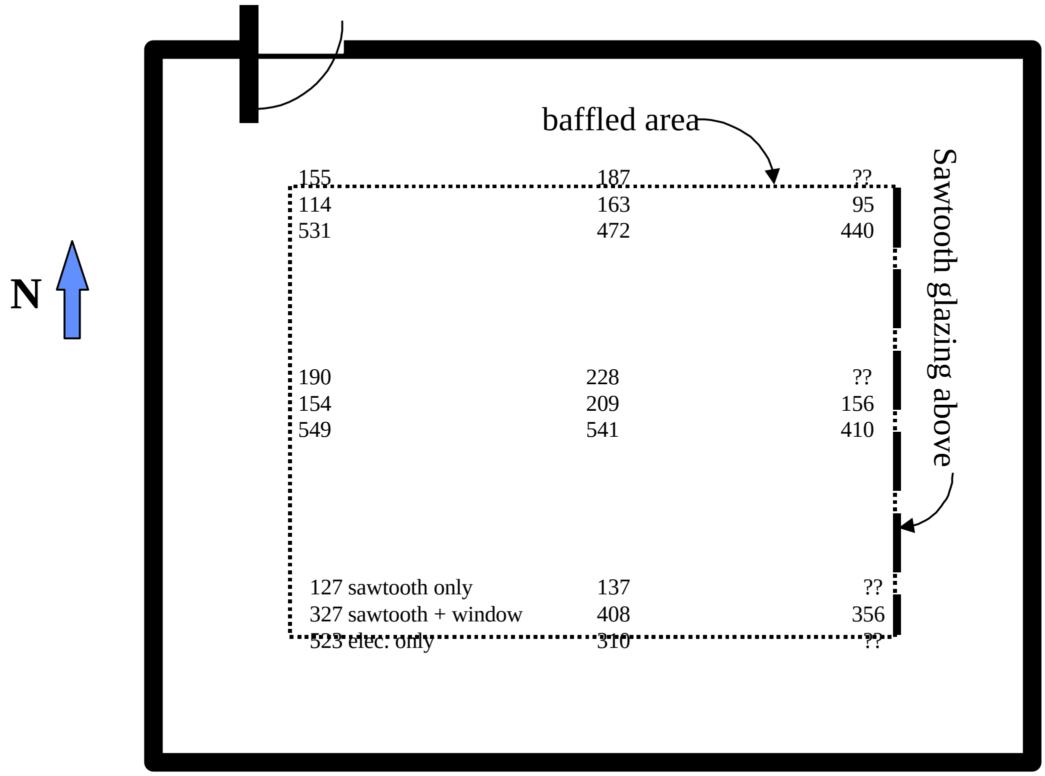
top: sawtooth only
mid: sawtooth + window
bottom: elec. light only



Lafayette: room 22

light measurements in lux
horiz. @ about 30”
exterior illum.: partly cloudy, 14300 - 35000 lux

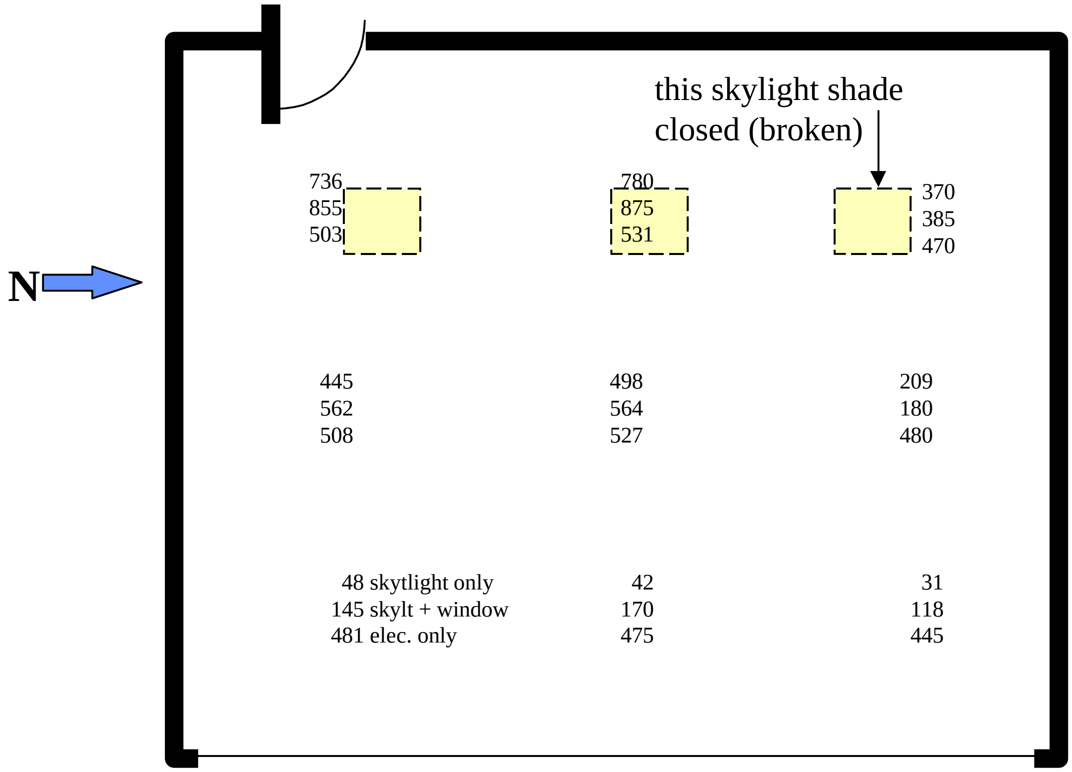
top: sawtooth only
mid: sawtooth + window
bottom: elec. light only



Rogers Elementary: rooms 9 and 4

light measurements in lux
horiz. @ about 30”
exterior illum.: high overcast, 27000 - 29000 lux

top: skylight only
mid: skylight + window
bottom: elec. light only



Fort Collins

Notes from the Elementary School Tour

The following are a crisscross of illuminance readings at 30” in a few select classrooms. All results are in footcandles and should be read with north as up, west as left and so on. Readings taken in February partially sunny weather. 1500+/- fc =10% daylight factor +/-

McGraw Elementary School

Media Center

			75			
			105			
			143			
101	109	127	135	135	124	81
			146			
			100			

Room 20

		100		
		133		
61	82	95	78	50
		46		
		66		

Miscellaneous Notes

20 fc in the center of the room with the shades drawn and lights on.

Johnson Elementary School

Room 5

		30		
		83		
59	136	140	90	60
		414		
		86		

Miscellaneous Notes

65 fc on chalkboard
Southeast corner very bright during sunlight – maximum of 445 fc on the horizontal

Kruse Elementary School

Room 24

		22		
		34		
65	69	65	54	60
		57		
		17		

Miscellaneous Notes

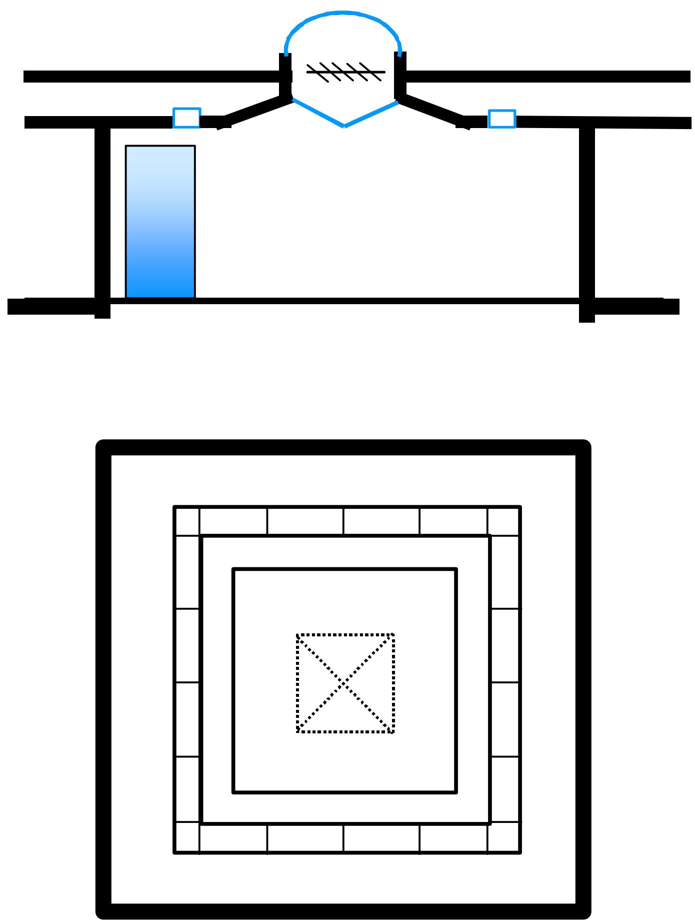
38 fc on chalkboard

Other Notes

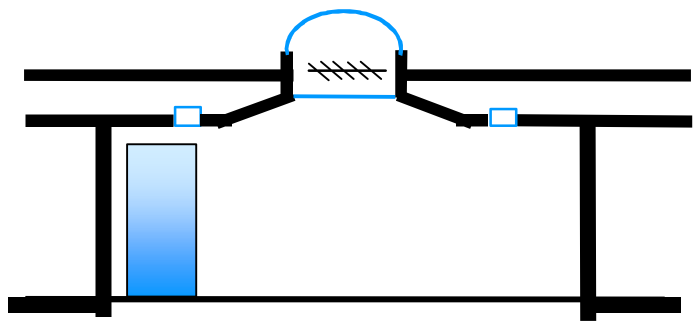
Classroom windows are roughly 75% transmittance in all buildings except for the windows on the west side of Werner Elementary. Werner has tinted glass which we estimated to have a 50% transmittance.

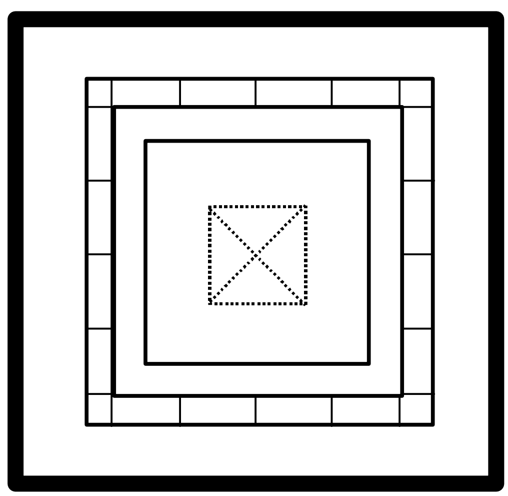
Classroom Plans

Capistrano: Skylight Type A

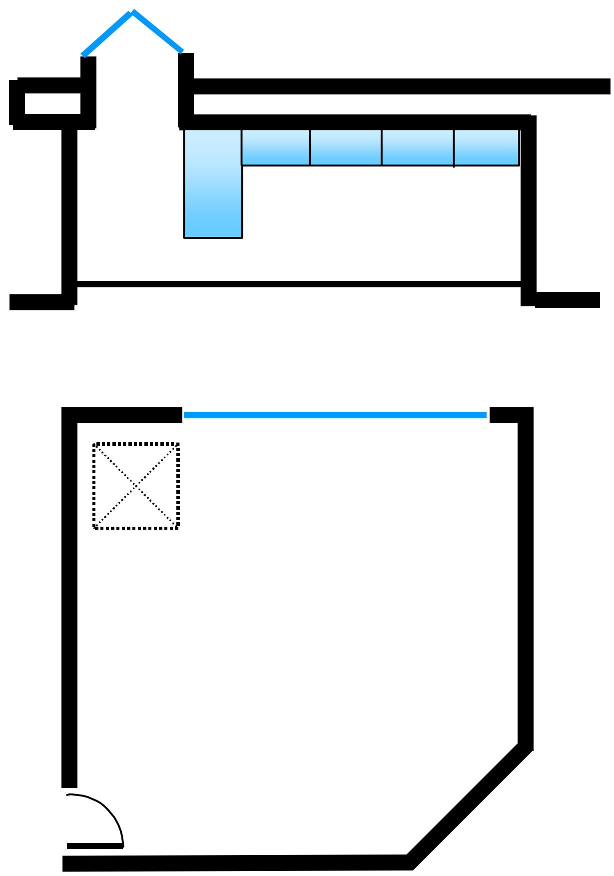


Capistrano: Skylight Type AA

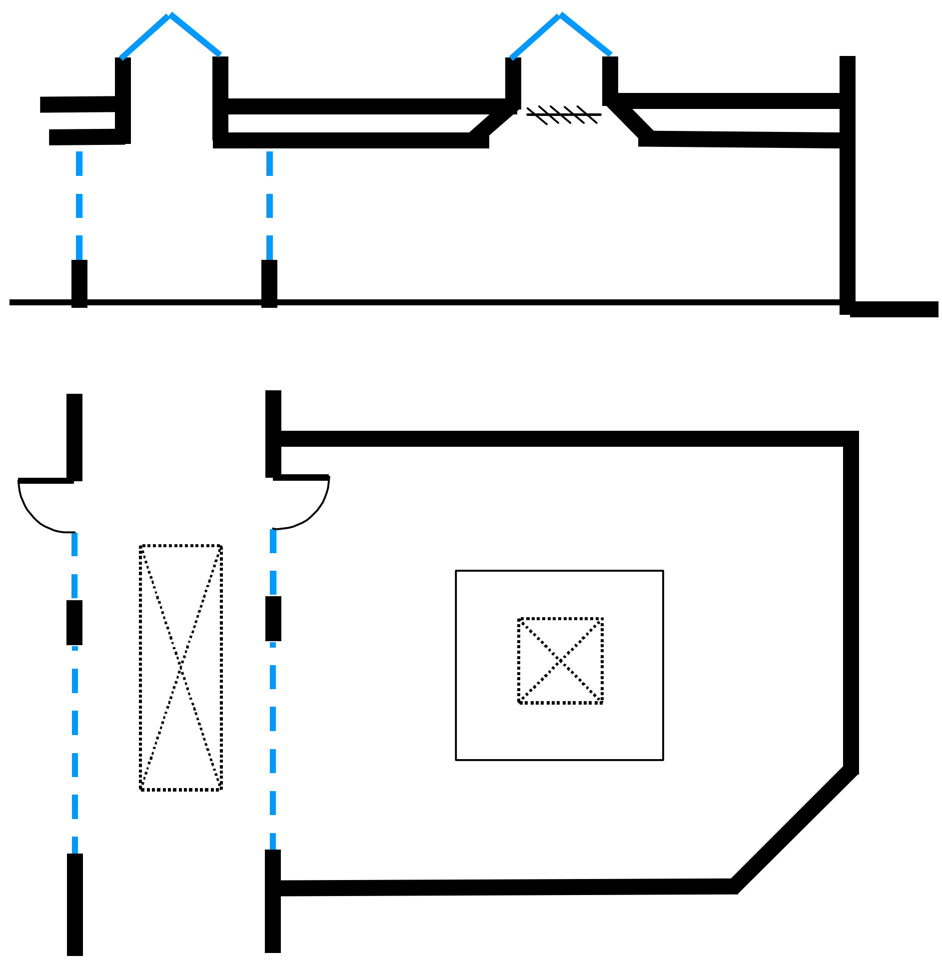




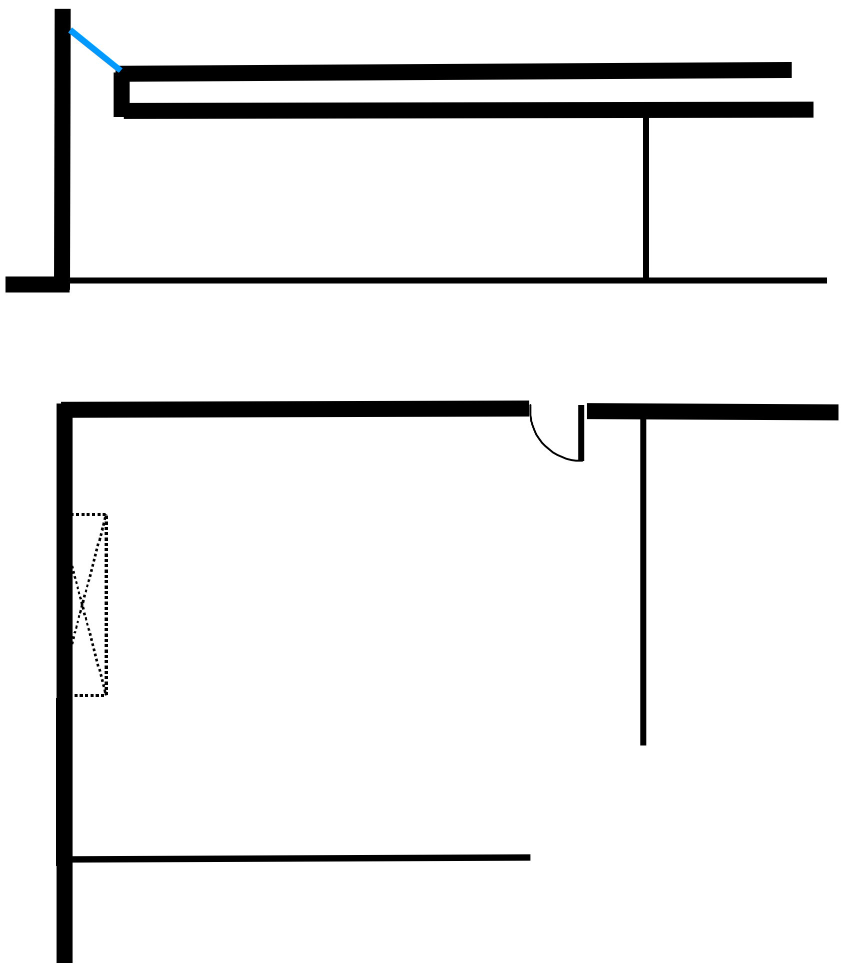
Capistrano: Skylight Type B



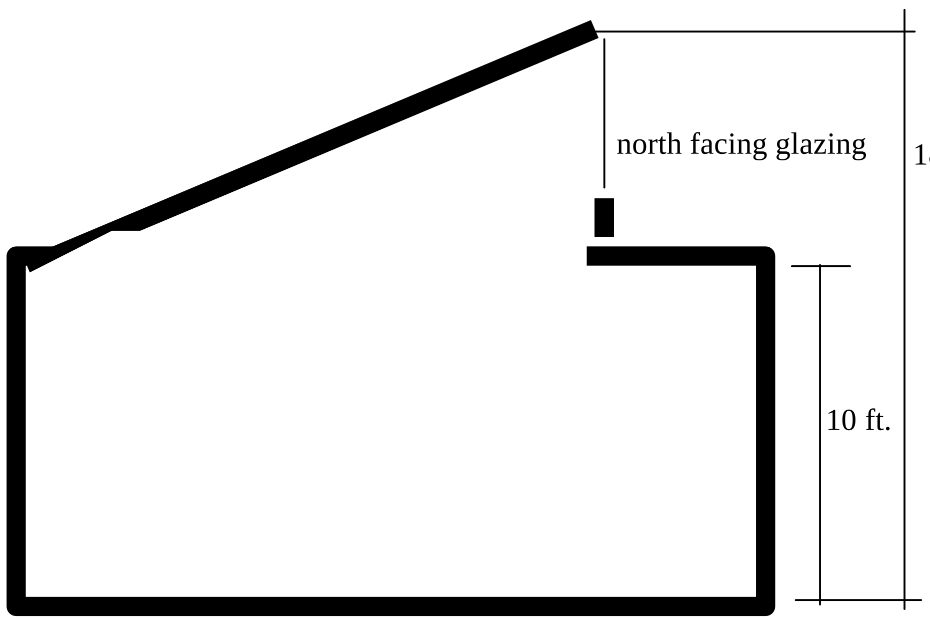
Capistrano: Skylight Type C



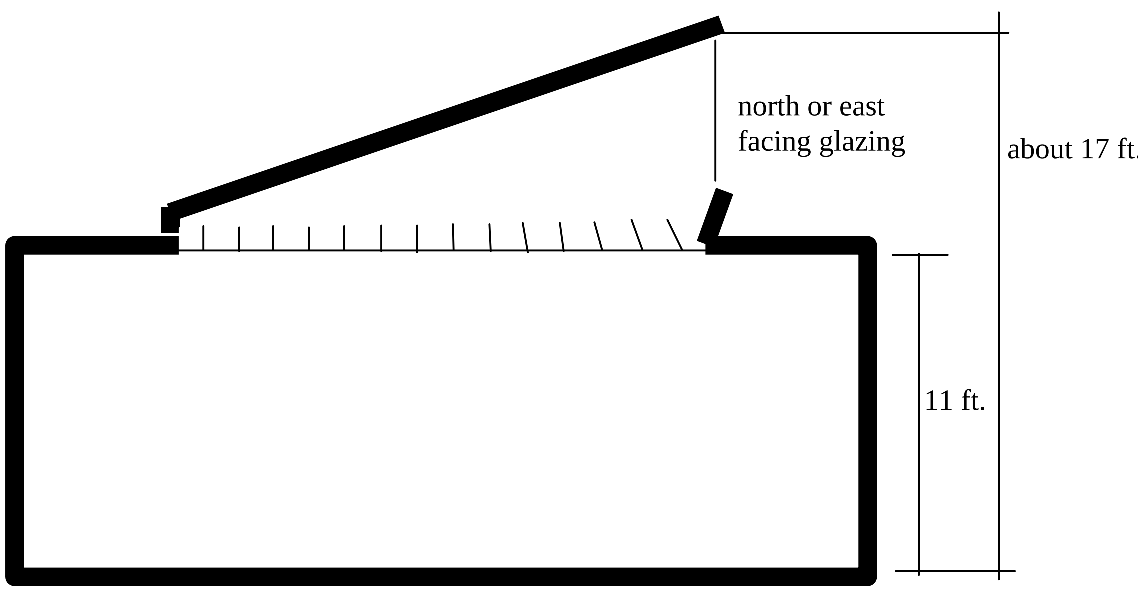
Capistrano: Skylight Type D



Seattle: Dunlap classroom section; Room 6; looking west



Seattle: Lafayette: section through sawtooth



Classroom Photographs

Capistrano Schools


Classroom with Maximum Daylight – Window 5


Classroom with Minimum Daylight – Window 1


Type A Skylight


Type B Skylight


Type B Skylight School


Type C Skylight


5 Window Code, and 5 Daylighting Code (South)


5 Window Code, and 5 Daylighting Code (North)


4 Window Code, and 3 Daylighting Code

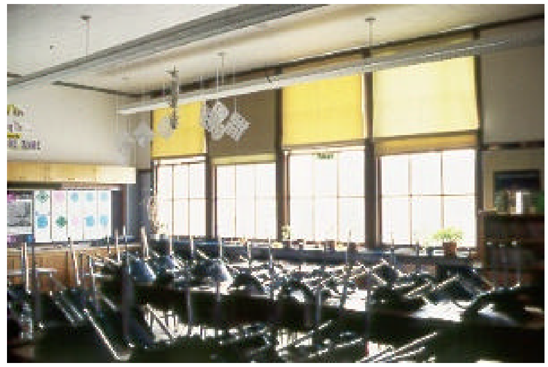

4 Window Code (North)


Portable Classroom Window 1, Daylight 2


Open Classroom Window 1, Daylight 1

Seattle Schools


Older Seattle School, Exterior


Interior of Classroom with Window Code 4


Classroom with Clerestory Windows


Central Skylight and Diffusing Louvers


Dunlap Elementary with Monitor


Rogers Elementary with Skylight

Fort Collins Schools


New School with Monitor Skylights


South Facing Monitor Skylights


Johnson Elementary School


McGraw Elementary School


South Facing Monitor Skylights


Same, without Electric Lights

McGraw Hill CONSTRUCTION Continuing Education

Daylighting in Schools, Grades K-12

Assisting daylight delivery while controlling electric light

December 2005

Advertorial course provided by Lutron

Susan K. Oldroyd, AIA

Benefits for incorporating daylighting principles into schools grades K-12 are twofold: reduction of energy consumption and costs by greater reliance on natural light, and improved human performance.

Continuing Education

Use the following learning objectives to focus your study while reading this month's Continuing Education article.

Learning Objectives - After reading this article, you will be able to:

1. Identify benefits of incorporating daylighting principles into schools grades K-12.
2. Describe architectural features used to increase effectiveness of daylighting in interior spaces.
3. Determine appropriate building controls for different types of school spaces.

Schools typically relied on daylighting as the primary source of illumination before fluorescent lighting became common. The California Department of Education required daylighting standards in school construction, so that all California classrooms built to handle the postwar baby boom in the 1950s and early 1960s were examples of daylit schools. The "Finger Plan" schools with rows of single classrooms with exterior corridors on both sides became a standard for grades K-12. However, in the late 1960s, air conditioning became common and school design changed. Classrooms were designed with less glass and lower ceilings, and rooms were grouped together in tighter configurations, without solar orientation in mind. The finger plan school design was largely abandoned, and many of the classrooms built since then do not have daylighting, and some rooms have no windows at all.

School districts across the country are experiencing K-12 construction starts in the first half of 2005 averaging four percent higher than the same period in 2004. $15.6 billion in constructions starts have begun to address overcrowding and inadequate facilities by constructing or renovating school buildings. The need for new facilities will continue to increase, according to Engineering News-Record and McGraw-Hill Construction Research & Analysis, especially in southern regions of the United States experiencing increases in school age populations due to relocation and immigration.

Southwest Community Center Gymnasium, Seattle, WA
This gymnasium uses fabric skylight baffles to diffuse glare and make electric lighting unnecessary during daylight hours. Architect: Weinstein A|U .
Photographer: Jamie Myers Forsythe

Initial costs are traditionally the most important in school construction budgets, but districts are increasingly focusing on sustainability, as case studies prove incorporating sustainable features into new K-12 schools can be realized within construction budgets, thus providing a more effective learning environment and saving resources. A sustainability measure increasingly integrated into building design is the use of daylight as a primary lighting element in classrooms, common areas, and even gymnasiums. Design features such as light shelves filter and reflect light to control glare and maximize diffuse natural light during K-12 operating hours, which coincide with daylight hours. Lighting controls, such as dimming ballasts, improve the light distribution when daylight is insufficient, and manage energy by turning off lighting by means of occupancy sensors. Clients from K-12 schools are learning the advantages of lighting controls such as energy savings and energy code compliance, while seeking simple, low-cost solutions.

Increased Student Performance

A 1999 study funded by the Pacific Gas & Electric Company and completed by Heschong-Mahone Group found that students get higher test scores when they learn in classrooms illuminated by daylight. This study of the correlation between daylight availability and test scores showed that natural daylighting in schools resulted in documented increases in student performance regardless of school design and climate. Three elementary school districts (Orange County, California; Seattle, Washington; and Fort Collins, Colorado) were studied. In Orange County, controlling for all other factors, students with the most daylighting in their classrooms progressed 20 percent faster on math tests and 26 percent faster on reading tests in one year than those students in classrooms with the least daylight; students in classrooms with the largest window area progressed 15 percent faster in math and 23 faster in reading than those with the least window area. In Seattle and Fort Collins, students in classrooms with the most daylighting had tests scores seven to eighteen percent higher than students in classrooms with the least daylighting. The authors conclude that there is a valid and predictable effect of daylighting on student performance.

Reduction of Energy Consumption

A white paper by Vivian Loftness, FAIA, titled Improving Building Energy Efficiency in the U.S.: Technologies and Policies for 2010 to 2050 (2005) lists the combination of daylighting and natural ventilation as one of the five most important directions for energy conservation in the following half century. “More than ten percent of all U.S. energy is used for lighting buildings, much of this during the day when daylight is abundant…. Effective daylighting can yield 30-60 percent reductions in annual lighting energy consumption, with average energy savings for introducing daylight dimming technologies in existing buildings at more than 30 percent…. Research using an advanced electric lighting control system has found that daylight-linked control systems can bring about sustainable reductions of 30–41 percent in electrical energy for an outermost row of lights in a perimeter zone, and 16–22 percent for the second row of lights."

Code Compliance

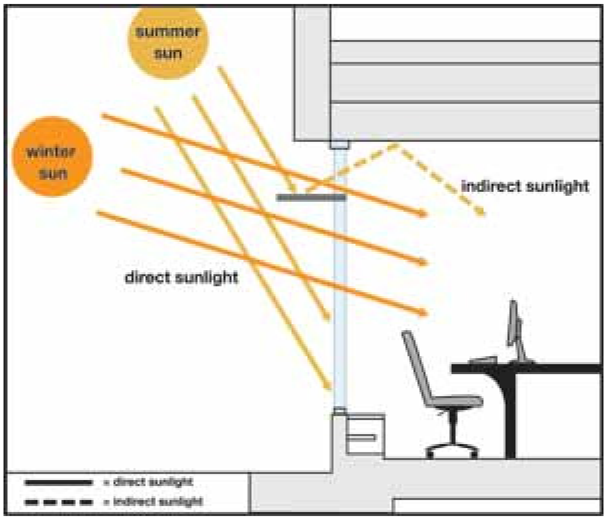
Energy efficiency is rapidly becoming the design requirement of the new millennium. Many states and cities have already adopted specific energy-saving guidelines. The following are examples of codes and standards that are being instituted in the United States:

- American Society of Heating, Refrigerating and Air-Conditioning Engineers/Illuminating Engineering Society of North America (ASHRAE/IESNA): This standard encourages the use of energy efficient-lighting controls in design practice for both interior and exterior lighting. Most states have or will adopt energy codes based on the standard.
- Leadership in Energy and Environmental Design (LEED): Efficient lighting controls may contribute to obtaining up to 22 points in five of six LEED credit categories. A minimum of 26 points is required for Leadership in Energy and Environmental Design certification. LEED is a rating system sanctioned by the United States Green Building Council (USGBC) that provides a national standard for what constitutes a green building.
- Title 24: California's building efficiency code (along with those for energy-efficient appliances) has saved more than $36 billion in electricity and natural gas costs since 1978.

Architectural Features

Daylighting control principles have two major requirements: directing diffuse daylight delivery into interior spaces and the control of electric lighting output in response to the available daylight. An integrated approach must be conceived from the beginning of the project including building siting and orientation, window and/or skylight design, and lighting and shading control systems design, as well as ongoing maintenance. Daylight, electric lighting, and shading systems cannot be considered separately because daylighting affects electric lighting use and has the potential of introducing direct sunlight and glare that may be uncomfortable for building occupants. This requires cooperation between architects and lighting engineers. Daylight, electric lighting, controls and building design features must be seen as an integral part of the overall energy optimization program.

Building form and orientation can be designed to capture more daylight opportunities. The floor plan configuration should maximize the perimeter daylight zone. This may result in a building with a higher skin-to-volume ratio than a typical compact building design. Other examples of design elements used in effective daylighting include light shelves, glazing modulation, and light monitors. A standard window can produce useful illumination to a depth of about one and one-half times the height of the window. As a general rule-of-thumb, the higher the window is placed on the wall, the deeper the daylight penetration. With lightshelves or other reflector systems this can be increased to two times or more. A light shelf is a horizontal light-reflecting overhang placed above eye-level with a transom window placed above it. This design, which is most effective on southern orientations, improves daylight penetration, creates shading near the window, and helps reduce window glare. Exterior shelves are more effective shading devices than interior shelves. A combination of exterior and interior shading devices will work best in providing an even illumination gradient. Carefully select and detail glazing and location and design of window openings. Glazing specification depends on the exposure; Low E glazing with light transmission of 50 percent should be used on the vision panels with 68 percent or greater transmission on glazing above the light shelf. No light shelves or shading devices, and all 68 percent or greater light transmission glazing should be used on the north side.



Section through exterior wall showing light shelf, Clackamas High School, Portland, OR: This section indicates daylight bouncing off light shelf onto ceiling, diffusing light throughout the space.

Light monitors can follow an east-west axis to maximize exposure to the southern sun. Top-lighting provides interior light that is significantly different from that provided by windows: it can provide relatively uniform light distribution throughout a space, and it is often easy to integrate with electric lighting because light originates from the ceiling in both cases. Roof monitors can be designed to admit daylight and sunlight, although sunlight is difficult to control and best avoided; a roof aperture should be between four to eight percent of the floor area. Shape the roof monitor to admit only daylight from the north. Splaying walls and using matte white reflecting surfaces around the monitor improves light distribution and reduces glare. Using diffusing glass gives better distribution of light if a view of the sky is not critical. Horizontal skylights may result in excessive solar gains in summer. Brighter sky visible through skylights can also cause glare problems. In addition to maximizing the penetration of diffuse light, the building features must diffuse or block direct rays of the sun. Glare and overheating from the sun's direct rays inhibits the performance of visual tasks in classrooms, offices and other similar spaces. In order for spaces to be considered daylit, The USGBC LEED Standard requires that no direct sunlight be admitted to critical task areas.

Control of Electric Lighting Output

Control of electric lighting output saves energy and improves the overall distribution of light when daylight is insufficient. A building designed for daylighting but without an integrated electric lighting system may even be a net energy loser because of the increased thermal loads. Only when the electric lighting load is reduced will there be more than offsetting savings in electrical and cooling loads. The benefits from daylighting are maximized when both lighting and occupancy sensors are used to control the electric lighting system. Combining lighting control strategies enhances building performance: Using occupancy sensors, daylight sensors, and time clocks with fluorescent dimming can help manage the lighting in an entire building and further reduce electric demand. Energy savings result when sensor and control technologies are employed in each classroom; maintenance is reduced because of less wear and tear on fixtures from using dimmers rather than on/off switches; and student productivity is increased through use of daylight and exact light levels for task needs.

Common School Lighting Control Functions	Benefits
Daylight Sensors and Dimming Ballasts	Reduced energy use
	Even light level throughout classroom
	Non-distracting light level changes
	Increased productivity
Occupant sensing	No wasted energy when classrooms are empty

Dimming wall controls	Saved scenes for various presentation and computer/ classwork needs

Table 1

Options for common school lighting control functions in classrooms, common areas, and other types of school areas can provide significant benefits. (Table 1.)

Mt. Angel high performance prototype classroom, Mt. Angel, OR: A rectangular suspended device dubbed "the halo" is made of translucent material that reflects part of the light onto the ceiling and walls, while letting part of the light into the room. Design team: BOORA, SOLARC, Prof. Charlie Brown of the Seattle Daylighting Lab, and SRG Partnership

New installations and retrofits require different approaches. With a new installation, performance targets can be set and a light source and shading device can be chosen based on economic, ergonomic, and technical considerations, e.g., an acceptable payback period. With existing installations, choices will be limited by the building constraints, the availability of daylight, and the lighting controls used.

Modeling Daylight in Interior Spaces

Joel Loveland, director of the Seattle Daylighting Lab, oversees his group's consultations with architects and lighting designers to shape school designs for maximum daylighting capability. The consultants prioritize daylighting as a building design goal, while working with the budget and programmatic requirements. Some of the design principles of the Daylighting Lab are:

- Treat the building as a luminaire.
- Separate the vision and daylight glazings.
- Position the daylighting apertures to create mood and visual focus.
- Address the requirements of the visual task.
- Integrate the daylighting system with the architecture.
- Integrate the daylighting system with the other building systems.

The Daylighting Lab uses modeling to predict exact natural lighting levels so that electric lighting and controls can be specified to work with and complement the daylight.

Cafeteria, Clackamas High School, Portland, OR: The cafeteria uses virtually no electric light.
Architect: BOORA

Prototype Classroom

A high performance prototype classroom in Mt. Angel, Oregon, created through the combined efforts of many experts and design firms, including BOORA, SOLARC, Prof. Charlie Brown of the Seattle Daylighting Lab, and SRG Partnership seeks to light a classroom during daylight hours without any electric light, with minimum cost. Electric light was added for the infrequent occasions when the classroom was used at night, but the large skylight opening on the ceiling distributes light to the entire classroom. A rectangular suspended device dubbed “the halo” is made of translucent material that reflects part of the light onto the ceiling and walls, while letting part of the light into the room. The edges of the room receive two sources of light, from the reflection and the direct light. This prototype is designed for single story ground floor buildings in moderate climates but the model could be adapted into two story buildings with light shafts, and other region and climate types.

Clackamas High School, Portland, OR

BOORA, Portland, OR, has developed successive daylit schools grades K-12 including Ash Creek Intermediate School, Monmouth, OR and Clackamas High School, Portland, OR. Most buildings spend more on cooling than on heating, so daylighting principles in schools typically focus on bringing in light rather than heat. In the case of Clackamas High School (completed in 2002 for $127.71 /s.f.) control of daylight was accomplished using light shelves and shading devices. Light bounces off the top of the light shelf into the ceiling of the first floor spaces. The overhang shades the window below it. This allows a higher visible transmittance glazing in the daylight aperture if it is out of normal sight lines. Since the ceiling is the most important light-reflecting surface, using this surface to bounce daylight deep into the room can be highly effective. Both of these strategies are utilized in light shelf designs. Rooms in this facility use occupancy sensors, timers and daylight sensors to control output of electric light. Two rows of suspended T-5 fixtures running parallel to exterior windows are used for supplemental lighting, with the inner row on dimming ballasts. Ceilings are shaped to reflect light more evenly throughout rooms. The cafeteria uses virtually no electric light yet offers a variety of light and dark options for students through means of mechanized window shades. (Figure 4.) Heinz Rudolph, FAIA, principal of BOORA, states, “When everything is said and done a building needs a mixture of daylight and electic light, and good control devices.”

Dimming Ballasts

Dimming fluorescent lighting instead of repeated switching helps to maintain lamp life. Dimming also saves electricity and reduces the demand on HVAC systems. Lighting output is adjusted to predetermined levels set during the commissioning process. A dimming unit smoothly varies the light output of electric lights by altering the amount of power flowing to the lamps. If daylight is less than the target illuminance, the control increases the lighting to provide the right amount on the work plane. Dimming controls in some situations save more energy than switching if they are linked to daylight and if lamps are dimmed at the start of their lifetimes to compensate for their increased output. Dimming controls are less obtrusive to occupants than switching, but a manual override is recommended in areas where occupants expect to have control. Switches can also used instead of dimmers, but this is not recommended except for limited applications because they are more obtrusive and may use more energy than dimming switches. High frequency dimming produces the greatest savings in all but the most well daylit rooms. A problem with photoelectric switches is rapid switching on and off when daylight fluctuates around the switching illuminance. This can annoy occupants and reduce life. Various techniques have been developed to reduce the amount of switching. Multi-level switching control uses two switching illuminances, one at which the lights are switched off and another, lower illuminance level at which the lights are switched on. Photoelectric switching with a time delay can also introduce a delay in the switching process.

Dimming ballasts replace non-dim ballasts in fluorescent fixtures, improving the energy performance and flexibility of any space.

Dimming is important because the human eye responds to low light levels by enlarging the pupil, allowing more light to enter the eye. This response results in a difference between measured and perceived light levels. A lamp that is dimmed to ten percent of its maximum measured light output is perceived as being dimmed to only 32 percent. Likewise, a lamp dimmed to one percent is perceived to be at ten percent. Descriptions of different levels of dimming follow:

- One percent architectural dimming provides very fine light level control to users for aesthetic effect or for very stringent lighting or audiovisual design criteria. Architectural spaces often have a strong focus on aesthetics and comfort, creating an environment that portrays class and distinction. Architects and designers create these spaces for maximum versatility and require subtle control of the lighting. Room types: theater, auditorium, lobby
- Five percent high performance dimming offers energy savings, aesthetic appeal, and space flexibility, allowing users to operate their lights at 100%, 5%, and anywhere in-between. Room types: meeting rooms, classrooms.
- Ten percent lighting management dimming works well for a classroom, cafeteria, or office lighting application. To maximize the benefits of a lighting management system, use dimming ballasts. Ten percent dimming is ideal for use in any space where saving energy is a primary goal. Room types: most spaces including classroom, library, cafeteria, meeting room, graphic art workstation, office, corridor/stairwell, utility room, restroom

Manual dimmers are available for incandescent, fluorescent, and certain high-intensity discharge (HID) sources. Both step and continuous dimming are available for incandescent fixtures. Multiple dimming methods are available for both fluorescents and HIDs, though HID dimming is limited by color rendition and flicker problems. Experience has shown that manual controls are not used effectively. Many occupants leave electric lighting on once it is switched on even if the illumination from daylight is at a level that would be considered adequate if the occupant were entering the space. Today, there are a number of light control systems that can cap the maximum light level provided by a manual dimmer, reducing the electricity used when lights are left on. Energy savings cannot be realized in daylit buildings unless the electric lights are dimmed or switched in response to the amount of available daylight. The energy savings achieved with daylight-responsive lighting controls will depend on the daylight climate, the sophistication of the controls, and the size of the control zones. An evaluation of currently available responsive control systems is presented in the International Energy Agency Solar Heating and Cooling (IEA SHC) Application Guide. This evaluation has shown that daylight-responsive systems used up to 40 percent less than non-controlled systems. Cooling load reductions have also been noted, which can save an additional two to three percent of electrical energy consumption. Savings can be larger than 40 percent especially in toplit spaces. In hot climates, the cooling savings can also be larger.

Photoelectric Light Sensors

A key element of all types of photoelectric control is the sensor, which detects the presence or absence of daylight and sends a signal to a controller that will adjust the lighting accordingly. Threshold on and off values can be set to respond to specific lighting conditions. These sensors can operate on/off switching of various luminaires or lamps within luminaires and they can also operate a continuous dimming system. Continuous dimming system may cost more than switching systems but they have greater user satisfaction because the change in lighting levels is not as noticeable. Added labor costs for additional wiring and circuits necessary for switching may increase the initial cost of a switching system.

Photosensors, also known as daylight sensors, monitor the amount of daylight present in a space. Daylight sensor shown above in actual size.

The location of the sensor is important because it influences the type of control algorithm used. The photoelectric cell or sensor is often located on the ceiling and is calibrated on site to maintain a constant illuminance level. A single sensor that dims large areas can cause problems if buildings or trees overshadow some parts of the interior space. It has been found that with innovative daylighting systems such as light shelves, a partially shielded sensor (shielded from the window only) is not susceptible to sky conditions and direct light from the window. A controller is located at the beginning of a circuit (normally the distribution board or the ceiling space) and incorporates an algorithm to process the signal from the photosensor and convert it into a command signal that is received by the dimming or switching unit. Photosensor-activated dimmers may be the most important dimming technique. It matches the available natural daylight and lighting system output to produce consistent illuminance. Electronic or other dimming ballasts allow for control of the light level. These systems require careful integration of control systems and sensors.

Occupancy sensors turn lights off when rooms are empty. Dual technology ceiling mount occupancy sensor shown.

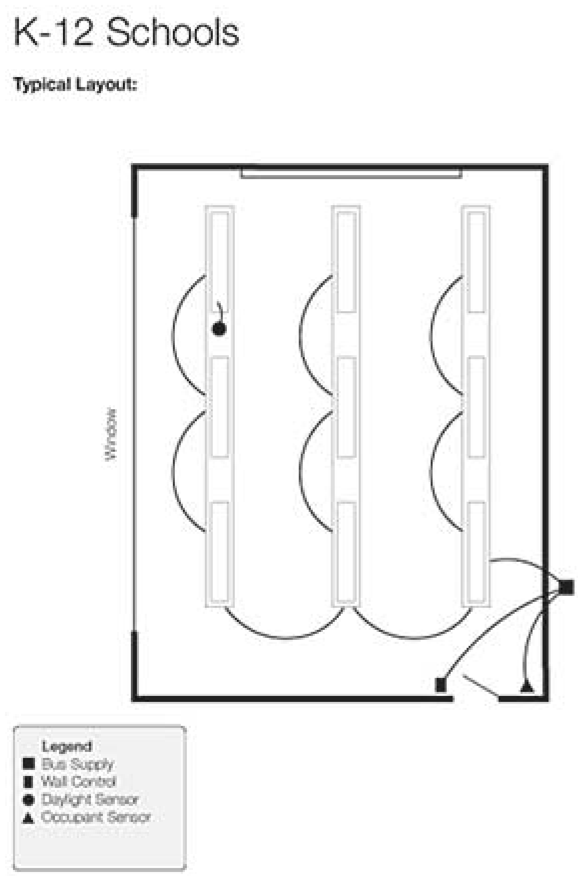
Occupancy Sensors

Occupancy sensors detect when a space is occupied by using passive infrared, ultrasonic, or a combination of the two technologies. Once the heat or movement of the occupant is no longer detected, and after a preset delay time, the sensor will emit a signal to extinguish the lights. Occupancy sensors used alone are good for low or intermittent use areas such as storage rooms, restrooms, private offices, and corridors. Sensors can be installed at a wall switch, wall mounted, ceiling mounted, or recessed in a pendant fixture depending upon preference and room layout.

Integrated Systems Software

Integrated systems software integrates environment sensors, such as daylight and occupant sensors, with personal controls, such as wall controls and infrared remotes. With 60 percent of energy use in schools going to lighting, the combined effect of multiple environment sensors and personal controls operating together brings energy savings to spaces that previously had none. Ballasts can be flexibly programmed, instead of wired, to work individually or as a group. This eliminates the need for an area to be rewired when changes take place, creating flexibility in a space that adjusts to shifting needs. Control software reduces lighting system maintenance. All of the environment sensors and personal controls connect directly to a ballast, removing interfaces, power packs, and control devices that on other systems require more parts, programming and maintenance.

Researchers have found that physical and perceived performance of a daylight control system can differ. If the user finds the environment created by the system to be uncomfortable or disturbing in any way (abrupt on-off switching), the system is likely to be rejected or an attempt will be made to compromise it. Energy savings are therefore directly related to a system's acceptance and proper operation by the user. Hard-to-operate systems are likely to be compromised. In addition, inappropriate ambience can result in rejection of the system. View aesthetics are also an important consideration. Users often do not accept daylight without view. In addition, the quality of light is important as is the avoidance of high contrasts and absolutely uniform lighting.



Typical layout of control devices in a classroom.

An important but often overlooked aspect of control installations is the training of maintenance personnel and building occupants in the operation and purpose of a daylight responsive control system. Although most manufacturers provide technical support during and for a period following installation of their systems, it is easier and more economical if those managing and occupying the building can address most problems. Building and facility managers need to be aware of how to operate the system and adjust it. They need to understand the system's performance. Building occupants should receive information about the purpose of the system.

Fluorescent lighting systems are the most common daylight control lamp source because of the availability of step switching and dimming systems. HID sources are typically not a good choice for daylight switching or occupancy sensors because of the extended strike and re-strike times. There are now two-step HID sources available that may be useful in some step switching applications where the "off" mode is not desired during a typical day. A daylighting design will use both occupancy and light sensors. With these two control strategies the lights will come on only when the room is occupied and only if there is insufficient daylight. In most designs, a manual override is provided for user convenience.

Modeling Daylighting

Physical models are a very effective way to analyze daylighting performance. Even simple models can begin to inform the designer of how daylight will behave in the building. It is important that the daylight apertures be accurately modeled and that the materials used to construct the model have the designed reflectance values. The model can then be tested on the actual site or under artificial sky conditions in a daylighting laboratory. A sundial with the appropriate latitude attached to the model base allows the designer to simulate various dates and times of the year. Computer analysis is another method of testing a daylighting solution. Typically a three-dimensional digital model is constructed using computer-aided design software that is then imported into the lighting software. The programs then require the operator to define all surface characteristics, sky conditions, location, and date and time. Many of these programs can produce photorealistic renderings of the proposed design.

To make informed decisions about the technology most appropriate for a space, designers must understand the daylight characteristics of that space. The physical daylight model is one of the most fundamental and useful tools for assessing and predicting daylight levels and qualities. One method of measuring and reporting a design's performance is in terms of daylight factors. A daylight factor is the amount daylight inside a space expressed as a percent of available exterior daylight. Photocells (light sensors) and a data acquisition system are used to measure daylight factors. Up to seven photocells are placed at strategic locations within the model measure interior light levels while a reference photocell placed on the model's roof measures available daylight. The value measured at each interior photocell is divided by that at the exterior reference value to determine daylight factors. The same equipment can also be used to measure absolute illuminance levels in lux and footcandles. Daylight distribution and absolute illuminance are not solely dependent upon building properties such as geometry, glazing selection, and the finish of interior surfaces. Exterior conditions including ground reflectance and horizon obstructions such as buildings and vegetation also influence interior lighting characteristics.

Originally published in the December 2005 issue of Architectural Record.

CLASSROOM LIGHTING

TOPICS:
The Value of Lighting Quality
Lighting Controls
Daylighting
General Classroom Layouts
Computer Classroom Layouts
Corridor Layouts
Lighting Fixture Specifications

CLASSROOM LIGHTING knowhow

Good lighting promotes better learning. Today's schools must provide a stimulating environment where children will learn best. High quality lighting improves students' moods, behavior, concentration, and therefore their learning.[1]

1 - Adapted from "Designing the Future," AIA Center for Building Performance.

Lighting quality means visual comfort, good color, uniformity and balanced brightness. This can be achieved with light-colored materials, glare control, distribution of light to ceiling and walls, and flexible lighting controls. These factors contribute to long-term system performance and aid in student concentration. Shadows, glare, lamp flicker or chaotic patterns can be distracting and should be avoided. (See the chart below for the importance of quality factors.)

This guide gives you the *knowhow* to provide "energy effective" lighting for classrooms – lighting systems that optimize energy use while creating a productive, comfortable, and adaptable learning environment. Energy effective lighting is the best use of financial and natural resources.

Classrooms with windows help keep children alert.

See back page for more information on daylighting.

George Leisey/Photographer, Bellows Falls, VT

Lighting on the walls and ceiling improves lighting quality.
Numbers refer to quality issues in chart below.

ACHIEVING BETTER & BETTER YET RESULTS

Classrooms often are lighted by recessed parabolic fluorescent 2' x 4' or 2' x 2' fixtures, systems that may not provide the best quality of light for learning. This *knowhow* guide shows you energy effective solutions that will deliver Better quality with improved energy efficiency. The Better Yet solutions identify further improvements, providing even greater long-term value for schools.

QUALITY ISSUES FOR SCHOOL LIGHTING

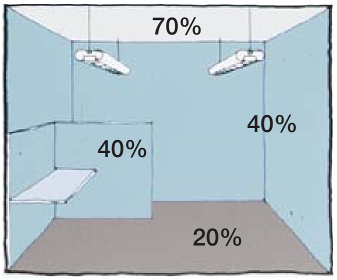
	General Classroom	Computer Classroom	School Corridor
Light on walls and ceilings (1) on photo above	●	●	◐
Control of direct and reflected glare (2)	◐	●	○
Uniformity (3)	◐	●	○
Daylight (4)	●	○	◐
Color rendering and color temperature	◐	●	◐
Lighting controls	●	◐	○
Quantity of light (horizontal footcandles)	40-50 fc	20-40 fc	10 vert. fc

● Very Important ◐ Important ○ Somewhat Important

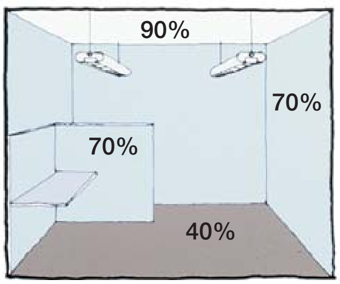
* Adapted from the Lighting Design Guide. IESNA Lighting Handbook, 9th Edition

how to achieve lighting quality

USE HIGHER REFLECTANCES



A small increase in room reflectances (lighter-colored surfaces) greatly improves efficiency. The lighter-colored room (below) provides 55% more light on the work surface for the same energy or uses 70% less energy for equivalent brightness. The lighter-colored room also provides better daylight distribution, improves brightness ratios, and is more visually comfortable. These significant improvements are possible at little or no additional cost.



Light is both reflected and absorbed by surfaces. Lighter colors reflect more than darker colors. When more light is reflected, room surfaces become more uniform and visually comfortable. Reflectances are deceiving – surfaces absorb more light than you think! Don't guess: verify finish reflectances with manufacturers.

CONTROL GLARE

Glare occurs when bright light sources and reflections interfere with the viewing of less bright objects. This high contrast may be uncomfortable or even disabling. Direct Glare is caused by fixtures located in front of students. Overhead Glare is caused by fixtures directly overhead. Reflected Glare is caused by bright reflections in surfaces such as glossy papers, shiny surfaces or computer screens. Glare control is especially important in flexible classrooms where desks and tables may face any direction, or in rooms with full time computer use.

GLARE PREVENTION TIPS

- Distribute light to walls and ceilings. Bi-directional fixtures such as A, D, and E (see p. 7) work well.
- Use daylight to light walls and ceilings.
- Use adjustable blinds or shades that control window glare while retaining view.
- Choose higher reflectance room surfaces.
- Select only semi-specular or white painted louvers and reflectors. Avoid mirrored or specular (shiny) reflectors or louvers that can be seen from any angle.
- Shield the lamp from view with baffles, louvers, lenses or diffusing overlays.
- Use lamps of lower brightness. Use more fixtures if necessary.
- Only use T5, T5HO and T5 biaxial lamps in coves or indirect applications where the lamp is not visible by classroom users.
- Use no more than three (3) T8 lamps in 2' x 4' fixtures.

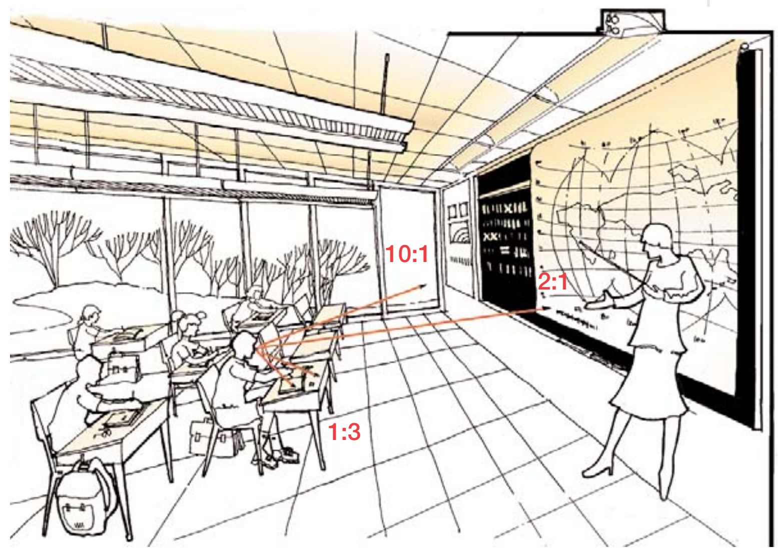
COLORS & FINISH TIPS

- Acoustic ceiling tiles are often only 70% reflective. Specify 80% or higher. Ceiling tile and paint companies list these values in their product specifications.
- Choose wall colors that are light in color (pastels) and at least 65% reflective.
- Choose furniture that is light in color (60% or higher).
- Always use matte (not shiny or high gloss) surface finishes for walls, ceilings, and furniture.
- Limit the use of primary or saturated colors to accents or wainscots, since they absorb a lot of light.

CREATE BALANCED BRIGHTNESS

Light levels throughout the classroom should not differ greatly from the light level on the desks. Large variations in brightness will cause distraction and fatigue.

- Use pendant light fixtures that direct at least 50% of the light upward.
- Avoid high contrast. The brightest and darkest room surfaces should be no greater than 3 times or 1/3 as bright as the task (preferred) or 10 times or 1/10 as bright as the task (maximum).
- For best student concentration, the brightest surfaces should be desk tops and focal walls.
- Use only semi-specular or white louvers to prevent harsh wall patterns.



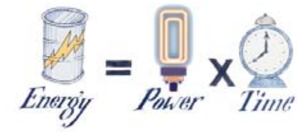
ACCENT FOCAL WALLS

The brightest surfaces should be the most important surfaces. Lighting the focal walls helps teachers catch and hold students' attention as well as to improve the visibility of information.

- For rooms where desks face one direction, provide focal lighting on the front wall or board.
- For multi-purpose spaces, provide focal lighting on two or three walls.
- Dedicate light fixtures (such as Type H, J, K) to accent these surfaces.
- Light levels on boards or focal walls should be at least equal to light levels on the desktop, or up to twice that level if the board is green or black. For uniformity, the edges of the board should not be less than 1/3 the brightness of the center.
- Locate fixtures 1 to 3 feet from the board or vertical surface so that light reflections do not obscure information on the board.

lighting controls

Lighting controls give teachers the flexibility to set the lighting level to match the tasks being performed. Controls also turn off lights automatically in an empty room or dim the electric lights when there is enough daylight. For lighting controls to operate properly, they must be checked and set at the beginning of each school year. Calibration and maintenance of lighting controls are essential for energy conservation.



Conserve Energy by:

- Reducing power. Use energy efficient sources, ballasts and luminaires. The power limit* for schools is 1.5 w/sf total connected load.
- Reducing energy use. Provide lighting controls to reduce the time of use (by switching) or level of power (by dimming).
- Wise design. Integrate daylight, room surfaces and layouts.
- Proper maintenance. Clean surfaces, group relamp, calibrate controls.

* ANSI/ASHRAE/IESNA Std. 90.1 - 2001

MATCH CONTROLS TO ROOM TYPES

	General Classroom	Computer Classroom	School Corridor	Potential Energy Savings*
Ceiling Occupancy Sensor, Manual-On, Auto-Off	●	●	○	30%
Multi-Level Switching with Ceiling Occupancy Sensor	●	●	○	35%
Daylight Controls with Occupancy Sensor	●	◐	◐	45%
Multi-Level Switching	●	●	◐	15%
Building Time Controls	◐	◐	◐	10%

● Appropriate ◐ Sometimes Appropriate ○ Not Appropriate

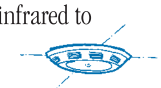
* As compared to standard manual switching for a 5,000 sq. ft. building with a 1.2 watts per sq. ft. connected load.

OCCUPANCY SENSORS

- Require that lights turn off automatically when spaces are not occupied.
- Use manual-on automatic switches (AS) with ceiling or wall mounted sensors (OS) for all spaces with daylight or receiving spill light from other rooms. Manual-on prevents unnecessary activation when daylight is adequate or when doors are opened. The switches also allow the lights to be turned off for AV purposes.

AS

- Manual-off is recommended only as a temporary override. Sensor must stay in automatic-off mode at all times.
- Use ultrasonic sensors – they are more sensitive than infrared to subtle motion and less likely to turn lights off in an occupied room. Dual technology is not required when sensor is to be used with manual-on capability.



OS

- Set sensors for medium to high sensitivity and 10-minute delay.
- Locate sensors inside classrooms so they do not "see" corridor motion.

OCCUPANCY SENSOR (OS) & PHOTOSENSOR (PS) TIPS

Optimum product locations, coverage areas and wiring requirements vary between products – work closely with manufacturers to verify appropriate coverage, installation and location. Redesign may be required if products are substituted during construction.

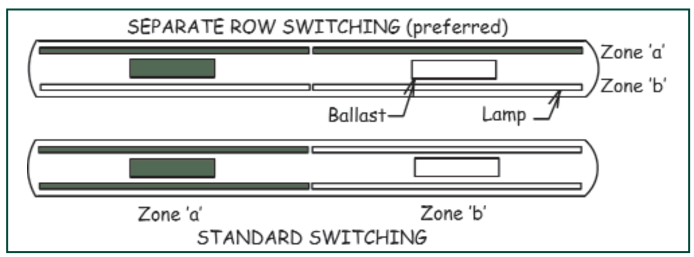
The row of lights closest to the window dims in response to daylight.

MULTI-LEVEL SWITCHING

- Avoid less-efficient one-lamp ballasts. Use master-slave wiring between adjacent fixtures and use multi-lamp ballasts. (See layouts 1, 6 & 7.)
- Use switchable two-level ballasts for three-lamp fixtures. Occupants can choose between two levels of light while maintaining uniform distribution.

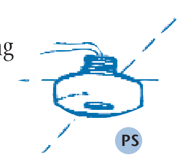
SEPARATE ROW SWITCHING

- Provide multiple levels in a uniform pattern by factory-wiring each row of lamps separately (shown below) or dimming. Avoid distracting switching patterns.



DAYLIGHTING CONTROLS AND PHOTOSENSORS

- Orient fixtures parallel to window wall. (See layouts 1 to 5.)
- Control each row of lamps separately.
- Continuous dimming is much better than switching – there are no distractions and greater energy savings. Electronic dimming ballasts typically dim to 10% of full output.



PS

- Start dimming when combined light levels exceed 125% of designed light level.
- Specify photosensors of the "continuous response" type.
- Use "open loop" controls, i.e. photosensor is located to respond to daylight only, rather than located to sense daylight and the electric light source being controlled. (See windows.lbl.gov/daylighting/designguide/designguide.htm for reference.)
- Specify a 60 second time delay to allow for temporary cloud cover.

classroom lighting

general and multi-purpose classrooms

What Makes Layout 1 ‘Acceptable’?

- Fixtures are oriented parallel to window; best for front focus, multipurpose uses, and daylighting.
- Fixtures use minimum 3” deep louver for greater comfort.
- Separate light on front board increases visibility and student attentiveness.
- Master-slave wiring saves energy by using multi-lamp ballasts.
- Occupancy sensors with manual-on switches save more energy in daylit spaces.

What Makes Layout 2 ‘Better’?

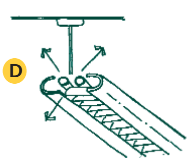
- More visually comfortable than recessed or totally direct fixtures.
- Wider distribution puts more light on walls.
- White louvers and spill light on ceiling reduce fixture glare.
- Two-level switching of continuous rows more uniform.
- Best choice for ceiling lower than 8’-9’.

Controls Upgrade: Switch fixture adjacent to window separately, and connect to photosensor for automatic response to daylight. This is more reliable than leaving daylight control to the teachers.
Alternative 2A: Add 3” stems and diffuser on top, to increase light on ceiling.

What Makes Layout 3 ‘Better Yet’?

- Combination direct/indirect more comfortable than totally direct or surface systems. Works well for part-day computer use.
- Direct/indirect more energy efficient than totally indirect systems.
- Pendants faster to install than recessed fixtures, and easier to maintain.
- Most cost effective. Greatest long-term value for investment.
- Overhead glare not a problem, due to T8 lamp and lighted ceiling.
- Wide distribution and white louvers reduce contrast and increase uniformity.
- Separate light fixtures accentuate front board.

Controls Upgrade:[3] Provide dimming ballasts and photosensor for better control of light levels.
Alternative 3A: Use Type D T-8 fixtures with parabolic louvers, to provide more shielding for intensive computer use.



LAYOUT TIPS FOR WIDER ROOMS

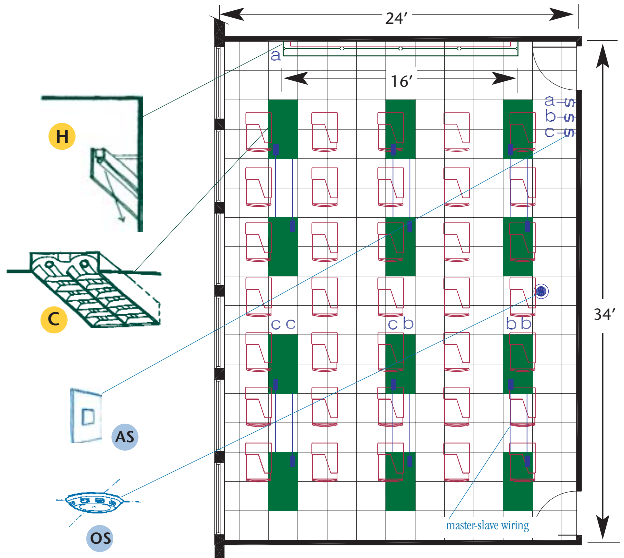
- For rooms 28 to 34 feet wide with continuous windows along the long wall, consider shifting both rows of fixtures 2 to 4 feet farther away from the windows.
- For rooms 34 to 38 feet wide, use three rows of fixtures.
- Perform lighting level calculations to verify expected light levels.

COMPARISON CHART FOR GENERAL CLASSROOMS

For classrooms from 750 to 850 sf.

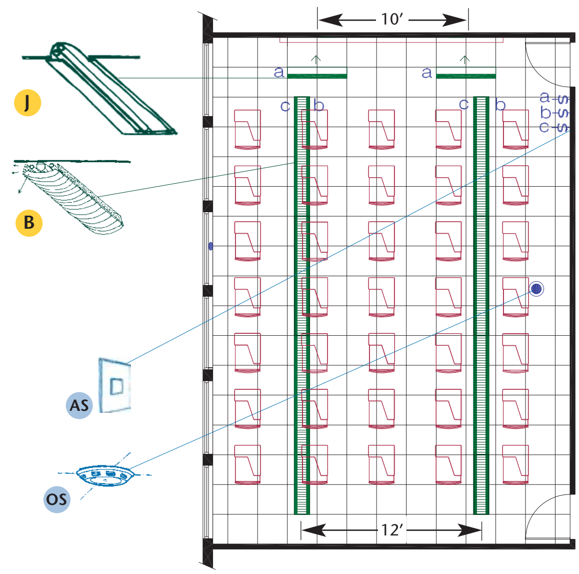
	Base Case[1]	Layout 1	Layout 2	Layout 3
Interest	★	★★	★★★★	★★★★
Uniformity	★★	★★	★★★	★★★★
Comfort & Quality	★	★★	★★★	★★★★
Power Density (w/sf)	1.32	1.01	1.16	1.16
Energy Savings (Potential %)[2]	Base	46%	40%	40%
First Cost (% Increase)	Base	40%	170%	115%
Maintained Footcandles (fc)	50-60	45-50	45-50	45-50
OVERALL VALUE		ACCEPTABLE	BETTER	BETTER YET

Layouts shown will meet light level requirements and current energy codes if they are within the given size ranges, between 8’0” and 9’6” ceiling heights. 1 - Base case assumptions used for comparison are 12 fixtures, recessed 3-lamp 2’x4’ parabolic 12-cell with T8 electronic ballasts and two-level switching. 2 - Includes savings due to controls shown. Control upgrades will yield greater energy savings. 3 - Go to www.designlights.org/classroomwiring/ for schematic daylighting control diagrams.



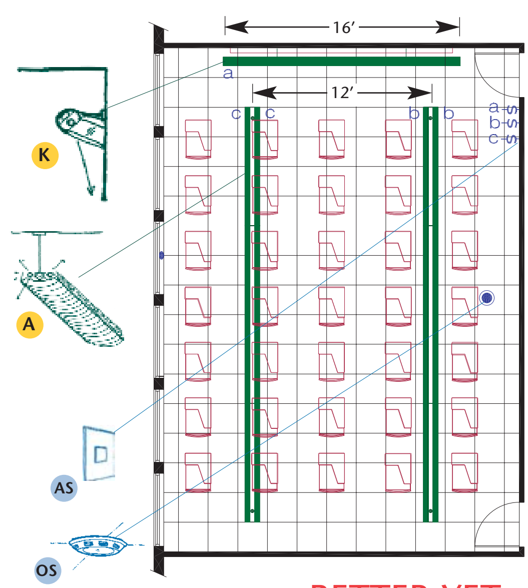
LAYOUT 1 – ACCEPTABLE

ACCEPTABLE



LAYOUT 2 - BETTER

BETTER



LAYOUT 3 – BETTER YET

BETTER YET

See page 7 for complete fixture specifications.

computer classrooms

COMPARISON CHART FOR COMPUTER CLASSROOMS

For computer classrooms from 750 to 850 sf.

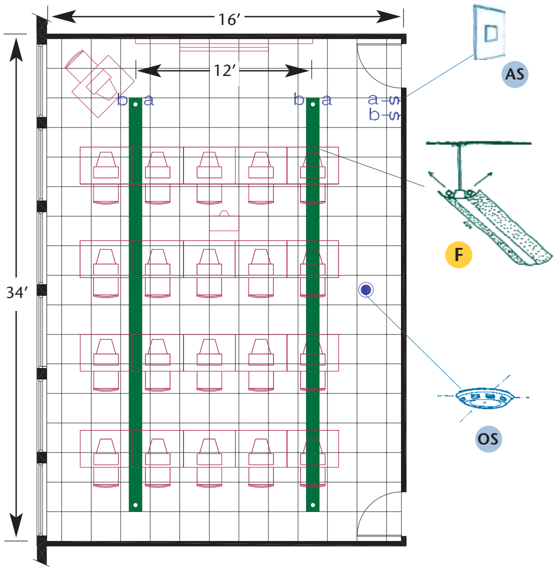
	Base Case[1]	Layout 4	Alt. 4A	Layout 5
Interest	★	★★	★★	★★★
Uniformity	★★	★★★	★★★	★★★★
Comfort & Quality	★	★★★	★★★	★★★★
Power Density (w/sf)	1.32	1.01	1.01	1.01
Energy Savings (Potential %)[2]	Base	46%	46%	46%
First Cost (% Increase)	Base	12%	30%	30%
Maintained Footcandles (fc)	40-50	35-40	30-35	35-40
OVERALL VALUE		BETTER	BETTER	BETTER YET

Layouts shown will meet light level requirements and current energy codes if they are within the given size ranges, between 8'6" and 9'6" ceiling heights. 1 - Base case used for comparison is 12 fixtures, recessed 3-lamp 2' x 4' deep-cell VDT parabolic, 27-cells, with T8 electronic ballasts and two-level switching. 2 - Includes savings due to controls shown. Control upgrades will yield greater energy savings.

Photo by Whitney Cox. Courtesy of Norman Rosenfeld Architect.

"Pendant fixtures can save installation time and cost, since they only require one power feed at the end of each row."

Electrical Contractor, Braza Electric



LAYOUT 4 – BETTER

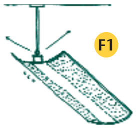
What Makes Layout 4 'Better'?

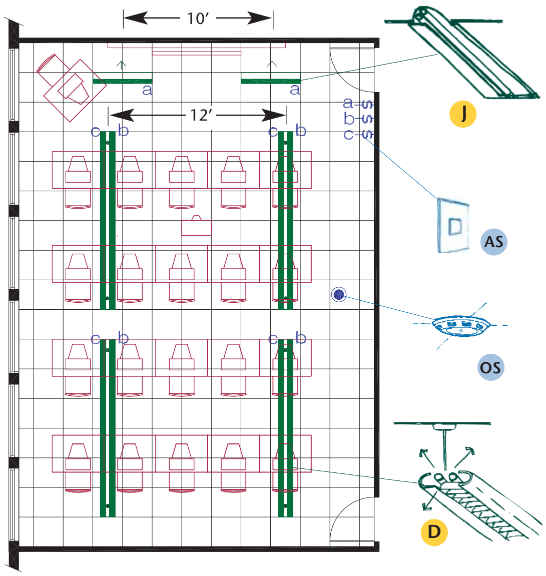
- Indirect lighting more comfortable than totally direct systems.
- No overhead glare.
- Greater uniformity of light on ceilings and walls.
- Two levels of control provide flexibility and energy savings.
- Glowing sides reduce contrast, increase comfort.
- Pendant fixtures faster to install and easier to maintain.

Controls Upgrade: Provide a third switch to control lamps nearest the front of the room for better contrast on video screen.

Alternative 4A: Same layout. Use fixture Type F1 with T5HO lamps. (See T5 box on page 6.)

- High lumen output of the T5HO lamp requires half the amount of lamps.
- Illuminance decreased. Appropriate for computer use only.





LAYOUT 5 – BETTER YET

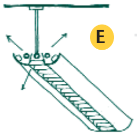
What Makes Layout 5 'Better Yet'?

- Combination direct/indirect more comfortable than totally direct.
- Direct/indirect more energy efficient than totally indirect.
- More cost effective. Greatest value for investment.
- T8 lamp and lighted ceiling prevent overhead glare.
- Higher light levels and 2-level switching more flexible for computer rooms with paper tasks.
- Separate fixtures used for front board when video screen not in use.

Controls Upgrade: Provide dimming ballasts and wall box dimmer for better light level control.

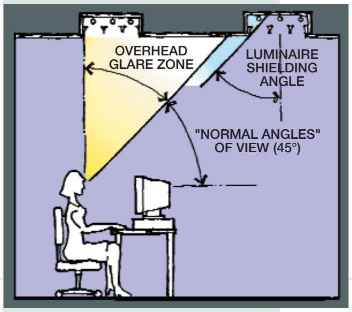
Alternative 5A: Same layout. Use Type E three-lamp T-8 fixtures.

- Direct and indirect components can be controlled separately.
- Greatest flexibility for rooms used for both computers and paper tasks.



Use A Different Approach for Computer Rooms

- Avoid totally direct lighting systems.
- Recessed fixtures leave ceilings dark. Contrast between bright lamps or lens and dark ceiling is too great for computer rooms.
- Specular (shiny) louvers or reflectors create overhead glare (see diagram) and harsh patterns.

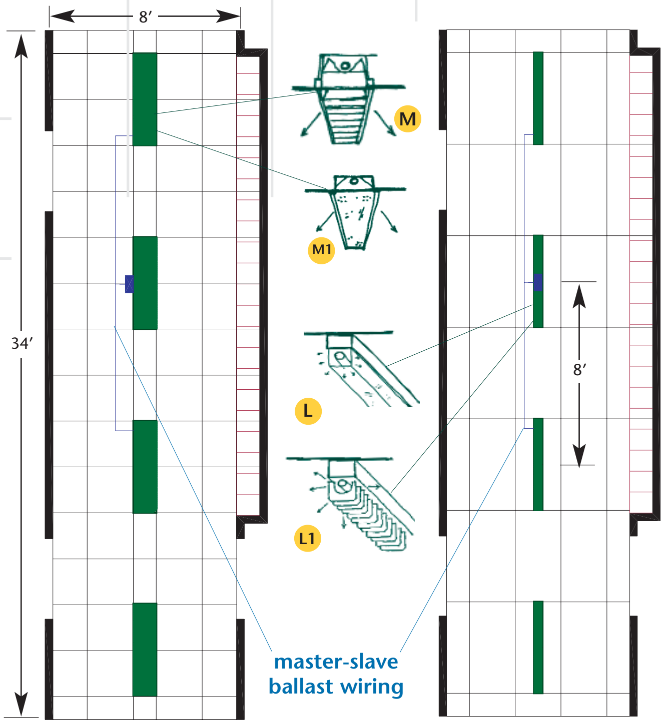


- Small-cell louvers are very inefficient and create cave-like rooms.
- Always provide some light on ceiling and walls. Distribute light as uniformly as possible.

school corridors

LAYOUT 6 – BETTER

LAYOUT 7 – BETTER YET



What Makes Layout 6 'Better'?

- One-lamp fixtures, oriented parallel to corridor, provide uniform distribution on lockers and walls.
- Master-slave ballast wiring saves energy by using multi-lamp ballasts.

What Makes Layout 7 'Better Yet'?

- Surface mounted fixture allows for greater ceiling height.
- Works well with any tile system and access panels.
- Wide distribution and white louvers provide most uniformity.

COMPARISON CHART FOR SCHOOL CORRIDORS

For corridors up to 9 feet wide.

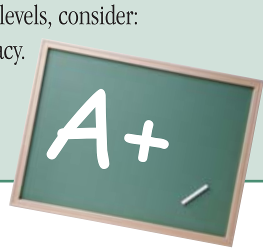
	Base Case[1]	Layout 6	Layout 7
Interest	★	★★	★★★
Uniformity	★	★★★	★★★★
Comfort & Quality	★	★★	★★★
Power Density (w/sf)	0.61	0.49	0.49
Energy Savings (Potential %)[2]	Base	20%	20%
First Cost (% Increase)	Base	60%	23%
Maintained Footcandles (fc)[3] on walls	5-15	8-12	8-12
OVERALL VALUE	ACCEPTABLE	BETTER	BETTER YET

1-Base case assumptions used for comparison are 2'x4' lensed fixtures, with two T8 lamps and electronic ballasts, spaced 12' on center, oriented perpendicular to the corridor, and on time clock control.
2-Includes savings due to controls shown. Layout tips for wider corridors: Layout 7 works for 10' corridor. Layout 6 limited to 9' corridor.

SCHOOL CODE TIP

If your state code requires minimum light levels, consider:

- Computer calculations for greater accuracy.
- Precise definition of task area.
- High output ballasts.
- Higher room reflectances.



T5 LAMPS

T5 lamps are not a replacement for T8 lamps. They are different lengths, use different sockets and ballasts, and have different pros and cons.

Advantages:

- Smaller size allows for greater reflector control.
- Smaller lamps and ballasts allow for smaller fixtures.
- Higher lumen output (T5HO) reduces the number of lamps and ballasts to maintain.
- Costs for T5 fixtures are competitive with T8 fixtures.
- Efficiency of T5 and T8 systems are comparable.

Disadvantages:

- Excessive brightness of T5 and T5HO limits their use to primarily indirect fixtures.
- Current replacement cost of components (lamps and ballasts) higher than T8, but will reduce over time.
- Using one T5HO lamp instead of two T8 lamps eliminates two-level switching options.
- Adds an additional lamp type to a project, complicating ordering, maintenance and repair.

lamp and ballast specifications

The following specifications apply to all of the fixture types shown on page 7 for both T8 and T5 linear fluorescent systems.

Lamp Criteria:

- Minimum Color Rendering Index (CRI) of 80.
- Color temperature of 3500 Kelvin or 4100 Kelvin. Provide mockup for other colors. Note: Generic color code "835" means CRI of 80 and color temperature of 3500.
- Mean lamp lumens (at 40% of rated life) at least 94% of initial lumens.

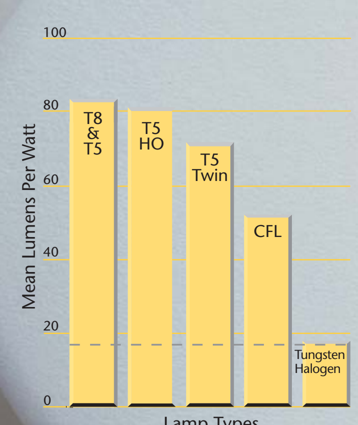
Ballasts and Lamp-Ballast System Criteria:

- High-frequency electronic using instant start or program rapid start circuitry.
- Harmonic distortion shall not exceed 20%.
- Ballast factor minimum 0.88 for T8 and 1.0 for T5.
- Consider "low" or "high" ballast factor ballasts to optimize lamp count, input watts, and power density. Limit any ballast type to only one type of fixture.
- Mean system efficacy (mean lamp lumens times # of lamps divided by ballast input power): Minimum 83 lumens/watt for 4' long T8 at 25°C and minimum 80 lumens/watt for 4' long T5HO at 35°C.

USE ENERGY EFFICIENT SOURCES

Fluorescent lighting today is not only more energy efficient, but rivals incandescent in quality, comfort and aesthetics. Lamps are available in a variety of superior colors providing a natural appearance for people and room colors. Electronic high frequency ballasts eliminate the flicker and noise of older model ballasts. The graph compares efficacies (mean lumens per watt) of common fluorescent lamp/ ballast combinations with the efficacy of a tungsten halogen (incandescent) lamp.

Lamp / Ballast Efficacies

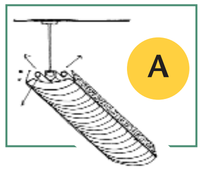


lighting fixture schedule

These specifications are for cost-effective fixtures that ensure a balance of performance, energy savings, comfort, lighting quality and ease of maintenance. Many standard products meet these generic specifications. Even small variations from these specifications may result in undesirable effects. For example, specular louvers or reflectors may increase light levels and reduce reflected glare, but will also increase overhead glare and decrease desirable room surface brightness.

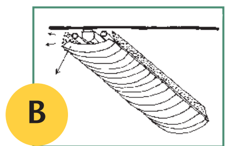
AMBIENT LIGHTING

A. Pendant Direct/Indirect Baffled



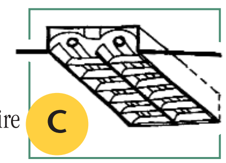
LAMPS: (2) 32W T8 fluorescent, 835 color
DESCRIPTION: Pendant mounted. White cross-baffles. Minimum 35° lengthwise shielding. Wire for separate row switching. Multi-lamp ballasts. 80% min. fixture efficiency. Nominal 59 watts per (2) lamps.

B. Surface Mounted Baffled, Wide Distribution



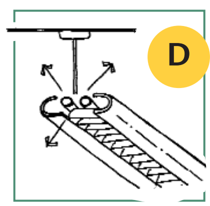
LAMPS: (2) 32W T8 fluorescent, 835 color
DESCRIPTION: Same as Type 'A' except surface mounted. Luminous sides for wide distribution. 60% min. fixture efficiency.

C. Two-Lamp Recessed Parabolic 2' x 4'



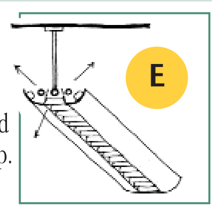
LAMP: (2) 32W T8 fluorescent, 835 color
DESCRIPTION: Recessed. White baked enamel reflector (minimum 90% reflectance) and minimum 3" deep parabolic louvers. 12 cells. Wire for separate row switching. Multi-lamp ballasts. 76% min. fixture efficiency. Nominal 59 watts per (2) lamps.

D. Pendant Direct/Indirect Parabolic



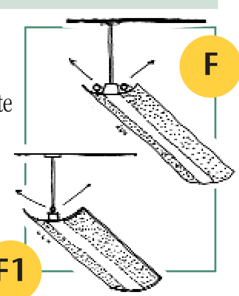
LAMPS: (2) 32W T8 fluorescent, 835 color
DESCRIPTION: Pendant mounted. Semi-specular low-iridescent parabolic cross-baffles minimum 1-3/4" deep, 3" on center. Wire for separate row switching. Multi-lamp ballasts. 80% min. fixture efficiency. Nominal 59 watts per (2) lamps.

E. Pendant Direct/Indirect Three-Lamp



LAMPS: (3) 32W T8 fluorescent, 835 color
DESCRIPTION: Pendant mounted. 2 lamps up and 1 lamp down. Semi-specular low-iridescent parabolic cross-baffles, minimum 1-3/4" deep and 3" on center. Optional lamp shield for center lamp. Wire for separate row switching. Multi-lamp ballasts. 71% min. fixture efficiency. Nominal 89 watts per (3) lamps.

F and F1. Pendant Indirect – Perforated Sides



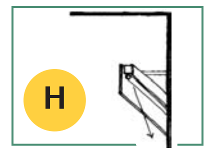
LAMPS: (2) 32W T8 fluorescent, 835 color
DESCRIPTION: Pendant mounted. 85% indirect component with perforated sides. Wire for separate row switching. Multi-lamp ballasts. 78% min. fixture efficiency. Nominal 59 watts per (2) lamps. Alternative F1: (1) 54W T5HO lamp, 95% indirect component. 88% min. fixture efficiency. Nominal 117 watts per (2) T5HO lamps.

George Leisey/Photographer, Bellows Falls, VT

Valances (Type H) are an inexpensive way to light focal walls, but don't provide the best uniformity.

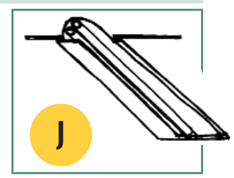
WALL ACCENT OPTIONS

H. Fluorescent Channel with Valance



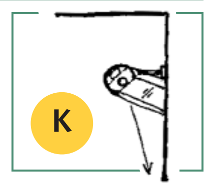
LAMP: (1) 32W T8 fluorescent, 835 color
DESCRIPTION: Surface mounted standard channel concealed by architectural valance. Multi-lamp ballasts. Nominal 30 watts per fixture.

J. Recessed 1' x 4' Linear Wall Wash



LAMPS: (2) 32W T8 fluorescent, 835 color
DESCRIPTION: Recessed wallwasher with semi-specular aluminum reflector. Locate 2' to 3' away from wall. Nominal 59 input watts per (2) lamps, 67% minimum fixture efficiency.

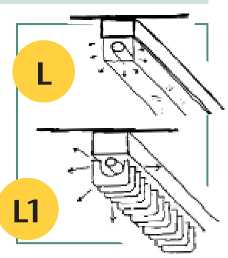
K. Bracket Mounted Asymmetric Board Light



LAMP: (1) 32W T8 fluorescent, 835 color
DESCRIPTION: Wall mounted. Asymmetric reflector. Cantilever 6" to 12" from board. Multi-lamp ballasts. 71% min. fixture efficiency. Nominal 59 watts per (2) lamps.

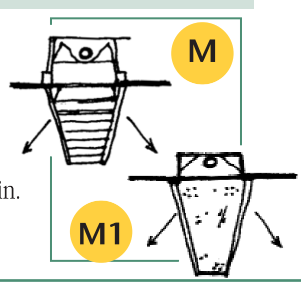
CORRIDOR OPTIONS

L and L1. Surface Mounted Corridor Wall Lighter



LAMP: (1) 32W T8 fluorescent, 835 color
DESCRIPTION: Surface mounted. White baked enamel housing and prismatic lens. Multi-lamp ballasts. 78% min. fixture efficiency. Nominal 59 watts per (2) lamps. (Available as pendant version if ceiling height is greater than 9'0".) Alternative: White cross baffles. 68% min. fixture efficiency.

M and M1. Recessed Fluorescent 1' x 4'



LAMPS: (1) 32W T8 fluorescent, 835 color
DESCRIPTION: Recessed. White upper reflector and white parabolic louvers 6" on center. Multi-lamp ballasts. Nominal 59 input watts per (2) lamps. 73% min. fixture efficiency. Alternative: Prismatic lens. 65% min. fixture efficiency.

daylighting

Daylighting is a key to lighting quality. Students with daylight in their classrooms (from windows and skylights) perform 20 to 25% better on reading and math tests than students without access to daylight.[2] The same study shows that students in classrooms with larger window areas progress up to 20% faster than their counterparts in rooms with smaller window areas. Go to http://www.h-m-g.com to read the study that presents these data.

DAYLIGHTING HINTS

Daylight only saves energy if the electric lights are dimmed or switched off. Dimming lights in response to daylight is less distracting than switching, but requires dimming ballasts and a commitment to maintenance. Avoid direct solar penetration – it creates glare and overheating. Use neutral-colored window glass and exterior overhangs to control window glare and solar heat gain.Balance the light by providing daylight from more than one direction. See page 3 and classroom layouts for daylight controls.

2 - The Heschong-Mahone Group (published 1999)

George Leisey/Photographer, Bellows Falls, VT

Students and teachers benefit from a connection to the outdoors – windows not only provide daylight but also a sense of time, weather, and distant focal points – all of which prevent fatigue and contribute to greater alertness in class.

better lighting = better learning

Research has shown that information presented visually is absorbed faster and retained more reliably than information presented orally.[1] To promote learning, provide an environment where teachers and students can perform their visual tasks comfortably, quickly and accurately. Lighting impacts the psychological and emotional needs of students: it makes a room attractive and pleasant, stimulates learning and improves behavior. High quality, energy effective lighting is a wise investment for our schools!

1 - Adapted from Good Lighting for Schools by Fodergemeinshaft GutesLicht.

"Visual richness in classrooms stimulates creative thinking. Quality lighting and flexible lighting controls are major contributors to a positive learning environment."

Professor, Texas Christian University

high quality checklist

- ☑ **Use fixtures that provide comfort by distributing some light on ceilings and walls, such as direct/indirect or semi-indirect fixtures.**
- ☑ **Use light-colored finishes on room surfaces to maximize reflected light.**
- ☑ **Include windows or skylights in every classroom.**
- ☑ **Design electric lighting to maximize benefits from natural lighting.**
- ☑ **Use interior blinds to control window glare.**
- ☑ **Use lighting controls to increase flexibility and decrease energy use for each room.**
- ☑ **Provide additional light for front wall or board, and other important room features.**

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More Daylight Means Healthier Environments

In the last 50 years we have industrialized many landscapes to maximize production with the lowest investment of time, resources, and labor. The educational landscape is much the same. In many modern schools, we have turned classrooms into windowless sweatshops.

Joel Loveland

Mies van der Rohe's classic call to action, "Less is more," has meant less fresh air, less natural light, and less building in many dimensions. Our children spend nearly 20 percent of their lives between the ages of 5 and 18 in school buildings that have been cost-engineered within an inch of their lives. Gone are high ceilings and great daylight, exchanged for generic shoebox classrooms with an 8' ceiling and, if students are lucky, a single small window. Especially in the average large high school today, it's not at all unusual to find "land-locked" classrooms without a window, buried deep within the core of the school. Who needs a window, say "value" engineers, when we have electric light, forced air, and fire-rated exiting pathways? These modern buildings are supposed to offer more efficiency and lower capital cost with a better building value. But what values are we accepting in the value equation? And most importantly, how do these designs affect the education, health, and well-being of our children and the teachers who spend their workdays in these buildings?

In the late 1990s, a massive change began in our understanding of what makes for a good learning environment. (*See sidebar for a brief history of classroom design.*) Lisa Heschong, with the initial support of the Pacific Gas and Electric Company of San Francisco, started to look at what physical characteristics of the classroom had the greatest influence on learning. Up until this time, laboratory research on such concerns as visibility and glare were the driving force behind the setting of building design standards.

Heschong, an architect, researcher, author, and teacher, used epidemiological techniques to study the effects of daylight on children's learning. She used standardized test scores for children in specific school populations, correlated to the demographics of the kids, their teachers, and the physical characteristics of their classrooms.

The Heschong Mahone Group (HMG) looked at 21,000 kids in 1,000 classrooms in three school districts in the western United States: San Juan Capistrano, California, Seattle, Washington, and Fort Collins, Colorado. (Reports of their work and the follow-up peer-group re-analysis by the State of California PIER Project are available at www.H-M-G.com.) Well daylighted classrooms in the 1999 study population correlated to a 20 percent increase in student math scores and a

School Design History in Brief

In the United States, our first public, or "common," schools were created in the late eighteenth century. These schools were sometimes in new buildings, but often were placed in storerooms just off the shop floor. By the late nineteenth century, public education had taken a firm hold across the US. One of Seattle's first public school buildings, BF Day Elementary School, constructed in 1896 and still in use today, best represents the nineteenth century design. It has small classrooms of 700–900 sq. ft. with tall ceilings, upwards of 13' high, and windows to match. The classrooms are shallow, no more than 26' deep from the window wall and wide across the building façade so as to gather the most light and fresh air.

With the post-World War II baby boom, design and construction of schools also boomed. The new schools were mostly suburban and one-story, since they had more room to sprawl. Because they were one-story, they tended to have much lower ceilings with daylight coming from one side or through skylights or clerestories. Daylight and natural ventilation were still the first items for consideration in these designs, but the late 1950s began to see the broad application of more efficient fluorescent lighting, fan-forced ventilation, and air conditioning. With the first highly engineered and detailed lighting and indoor air quality standards set in the late 1950s and 1960s, daylight and natural ventilation were deemed too uncontrollable and unreliable. The window was seen as of no value to the classroom. The last nail in the coffin of the window was the energy crisis of the early 1970s. Those schools that hadn't adopted the open classroom of the 1960s and eliminated most, if not all, windows now boarded up their windows to reduce their use of energy for heating.

By the late 1970s the typical classroom had gone from 24' deep and 32' feet wide across the window wall to 32' deep and 30' wide. The exterior wall was mainly solid, with only 5 percent of its surface glazed with an inoperable window, in contrast to the classroom of 1900, where as much as 50 percent of the wall in the shallow and wide classrooms windowed! ■

26 percent increase in reading scores over non-daylighted classrooms. This epidemiological correlation was built with 99.8 percent certainty. A 2002 re-analysis of this work by the California PIER project confirmed the 1999 results. Since 2002, the HMG has reported other similar work in other school districts that correlates about half of this increase in test scores to access to daylight and half to the access to views of nature.

The difficulty in such epidemiological work is the detection of the mechanism for the difference in observed behavior. What actually caused the increase in test scores? The idiosyncratic nature of the activities in buildings complicates an understanding of the effects of the complex variables of the built environment on our behavior or performance.


UW BetterBricks Daylighting Lab

Riverview Elementary School, in Lebanon, Oregon, is an example of the new direction school building design is taking. Large, operable windows allow both daylight and fresh air into all parts of the classroom.

Bringing daylight back into schools

In many districts, such as in Spokane, Washington, the building process has started with community input on the priorities for building values. Fresh air and daylight rise consistently to the top of the list. In California, schools must be certified as meeting the Collaborative for High-Performance Schools (CHPS) criteria (see www.chps.org). In Washington, the state has invested in an elective set of high-performance criteria titled the Washington Sustainable Schools Protocol.

With Heschong's ongoing epidemiological research in human performance as related to building design, these new research efforts have been the major stimulus to the setting of new "high-performance" building and school design standards in the Pacific Northwest. This advanced work in building performance can be seen in the integrated high-performance designs of such completed schools as Ashcreek Middle School in Independence, Dalles Middle School in The Dalles, and Riverview Elementary School in Lebanon, Oregon. The three Oregon schools, designed by Heinz Rudolf, a partner at BOORA Architects of Portland, were completed in 2002 and 2003 for standard construction budgets for Oregon public elementary and middle schools.

The high-performance classrooms of the twenty-first century are illuminated with diffuse and well-balanced daylight and need no electric light for more than half of the school year. Many of these schools use their daylighting windows for natural ventilation, thus eliminating the requirement for refrigerated air conditioning.

School building design has arrived at a moment in time where less does equal more. Less electricity used for lighting and air conditioning means students of the Pacific Northwest will feel healthier and learn more, while districts use less electricity.

Author

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Lighting Commercial Buildings

Research efforts in commercial settings have linked large increases in retail sales to daylight from skylights. Major retailers such as Wal-Mart and Albertsons have designed their national prototype stores to consider daylight as their primary source of ambient illumination during daylight operating hours. By extension of this research, designers of other buildings, such as hospitals, senior housing, health care, and offices, are adjusting their designs to reflect the importance of daylight and views to the outdoors.

The non-vision effects of light and daylight, in particular, are drawing increasing attention. It has long been known that the window-side patient in a two-patient hospital room tends to improve more quickly. More recently the *New York Times* reported that the neonatal intensive care unit at Duke University had experimented with brighter illumination during the day, when the babies' mothers would have been exposed to higher daylight illumination. This circadian simulation was found to be associated with quicker growth and earlier release than non-circadian-stimulated babies. Dr. Roger Ulrich, director of the Center for Health Systems and Design at Texas A&M University, has linked patient recovery rates from surgery to daylight and views from hospital recovery room windows. Similar associations have been discovered in Alzheimer's patient care facilities. Again, getting patients exposed to daylight (or illumination using daylight spectrum) during critical daytime periods was found to better orient the patients and allow for less wake-interrupted sleep at night. In the last year an elderly housing facility was built in the Portland area with careful consideration of these daylighting and circadian rhythm concerns. Dayrooms where residents can be exposed to serotonin-stimulating "showers" of daylight illumination in the winter months were built as an integrated part of the facility.

The BetterBricks program of the Northwest Energy Efficiency Alliance, a nonprofit agency funded by Pacific Northwest region electrical utilities and public and private agencies, is at the forefront of supporting these new integrated building design concepts, since they also conserve energy. The Alliance's BetterBricks Design Labs in Seattle, Portland, Eugene, Spokane, Boise, and Bozeman are tasked with supporting the implementation of these integrated design concepts in commercial and institutional buildings throughout the Pacific Northwest. ■

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Daylighting and Productivity - CEC PIER

Executive Summaries

Windows and Offices: A Study of Office Worker Performance and the Indoor Environment – CEC PIER 2003

This study reports on an investigation into the influences indoor physical environment has on office worker performance. It is particularly concerned with the potential contributions of windows and daylight to improved performance by office workers. Two different studies were conducted at the same organization, the Sacramento Municipal Utility District. The first study looked at 100 workers in an incoming call center, whose performance was continuously tracked by a computer system and measured in terms of time to handle each call. The second study examined the performance of 200 other office workers on a series of short cognitive assessment tests, taken at each individual's desktop computer.

The study sites provided a range of daylight, view and ventilation conditions, while providing a relatively uniform environment for other potential influences on worker performance. All of the office work considered was computer-based, based on self-illuminated tasks. Extensive data was collected about the physical environment at each office worker's cubicle. Multivariate regression analysis was used to control for other potential influences, such as age or employment status. A variety of statistical models were tested to determine if any of the variations in environmental conditions, either between workers or during different time periods for a given worker, were significantly associated with differences in worker performance.

The studies found several physical conditions that were significantly associated ($p<0.10$) with worker performance, when controlling for other influences. Having a better view out of a window, gauged primarily by the size of the view and secondarily by greater vegetation content, was most consistently associated with better worker performance in six out of eight outcomes considered. Workers in the Call Center were found to process calls 6% to 12% faster when they had the best possible view versus those with no view. Office workers were found to perform 10% to 25% better on tests of mental function and memory recall when they had the best possible view versus those with no view. Furthermore, office worker self reports of better health conditions were strongly associated with better views. Those workers in the Desktop study with the best views were the least likely to report negative health symptoms. Reports of increased fatigue were most strongly associated with a lack of view.

Other variables related to view were also found significant. In the Call Center higher cubicle partitions were associated with slower performance. In the Desktop study glare potential from windows was found to have a significant negative effect on performance in three of the five mental function assessment tests. In the three tests, the greater the glare potential from primary view windows, the worse the office worker performance, decreasing by 15% to 21%, all other things being equal.

Horizontal daylight illumination levels were found to have an inconsistent relationship to performance, significant in two out of eight metrics tested. Higher levels of daylight illumination were found positive for Digit Span Backwards, a test measuring attention span and short term memory, and negative when compared to changes in daily average speed of handling calls for one of two study periods. The natural log of daylight illumination levels was found to have the best mathematical fit to the data, implying more sensitivity to changes at lower levels of illumination and progressively less sensitivity at higher levels.

Ventilation status and air temperature were also found to have significant, if intertwined and occasionally contradictory, associations with worker performance. When variation in hourly performance at the Call Center was considered, higher rates of outside air delivery were significantly associated with faster handling of calls.

Overall these potential influences on worker performance were found to have high statistical significance in the models tested. They are related to performance that is 1% to 20% better or worse than average. All together information about the physical conditions of the workers was able to explain about 2% to 5% of the total variation observed in a measure of worker productivity (Call Center study) or in performance on short cognitive assessment tests that were thought to be related to worker productivity (Desktop study).

Even small improvements in worker productivity are of great practical importance, and explaining 2%-5% of total variation is not trivial. By way of comparison, all other available information typically believed to predict performance such as demographic characteristics or employment status was able to explain about 6% to 19% of the variation in their performance. Thus the characteristics of the physical environment represent about 1/8th to 1/3rd of our entire ability to predict variation in individual worker performance.

Furthermore, changes in the physical design of a space that may influence worker performance are likely to have great persistence, continuing for the life of the building. When compared with the costs, persistence and the certainty of other methods of increasing productivity, constructing well-designed buildings may be attractively cost-effective. As demonstrated in the study site, these same features can also provide additional energy cost savings.

Both studies successfully measured variation in office worker environmental conditions and related these to measured office worker performance under actual employment conditions. The Desktop study pioneered the use of computerized cognitive assessment tools to gauge office worker performance in field conditions. The studies have shown that indoor environmental conditions can have a measurable relationship to changes in office worker performance and have established a range of likely effect sizes that other researchers can use to refine the needs of future studies. Other studies will be required to test if these findings can be replicated in other settings and to explore potential causal mechanisms between the environmental conditions and worker performance.

Windows and Classrooms: A Study of Student Performance and the Indoor Environment – CEC PIER 2003

This study investigates whether daylight and other aspects of the indoor environment in elementary school student classrooms have an effect on student learning, as measured by their improvement on standardized math and reading tests over an academic year. The study uses regression analysis to compare the performance of over 8000 3rd through 6th grade students in 450 classrooms in the Fresno Unified School District, located in California's Central Valley. Statistical models were used to examine the relationship between elementary students' test improvement and the presence of daylight in their classrooms, while controlling for traditional education explanatory variables, such as student and teacher demographic characteristics. Numerous other physical attributes of the classroom were also investigated as potential influences, including ventilation, indoor air quality, thermal comfort, acoustics, electric lighting, quality of view out of windows, and the type of classroom, such as open or traditional plan, or portable classroom.

Previous Studies

This study is the third in a series of studies looking at the relationship between daylighting and student performance. The first, Daylighting in Schools,[1] which was completed for Pacific Gas and Electric in 1999, examined school districts in three states. In Seattle Washington and Fort Collins Colorado, where end-of-year test scores were used as the outcome variable, students in classrooms with the most daylighting were found to have 7% to 18% higher scores than those with the least. In San Juan Capistrano, California, where the study was able to examine the improvement between fall and spring test scores, we found that students with the most daylighting in their classrooms progressed 20% faster on math tests and 26% faster on reading tests in one year than in those with the least.

A second study, the Daylighting in Schools Reanalysis Report[2] completed for the California Energy Commission in 2001 further investigated the results from the Capistrano school district. We investigated whether better teachers were being stationed in more daylit classrooms, and thereby inflating the importance of the daylight variable. In that district, we found that there was no assignment bias of better teachers to more daylit classrooms. Furthermore, the addition of information about teacher characteristics to the original student performance models did not reduce the significance or magnitude of the daylight variables. Among twelve models considered in that study we identified a central tendency of a 21% improvement in student learning rates from those in classrooms with the least amount of daylight compared to those with the most.

Fresno Study

This study's primary goal was to examine another school district, one with a different climate and curricula, to see whether the original methodology and findings would hold. We collected more information about the lighting and daylighting conditions in the classrooms, to allow us to test which attributes of a daylit classroom were more likely to contribute to a "daylight effect," if any. We also wished to understand how other aspects of the indoor environment affected student performance and interacted with daylight. To accomplish these goals, this study gathered detailed information about classroom conditions, including lighting and daylighting, HVAC, ventilation, windows, surface coverings, view, and indoor air quality. Whereas we had done on-site surveys only a sample of classrooms for the previous studies, for this study we went on-site to measure attributes in every classroom, surveying a total of 500 classrooms in 36 schools.

The preliminary statistical analyses replicated the structure of the models used in the previous studies. They used a holistic variable called the Daylight Code to rate classrooms by the amount of daylight available throughout the school year. In these replication models, the Daylight Code was not significant in predicting student performance for Fresno. It had the least explanatory power of the variables considered, and lowest significance level. Thus, we could not replicate the Capistrano findings based on a similar model structure. We proceeded with more detailed statistical analysis to see if we could identify specific influences of school or classroom design on student performance, and perhaps gain some insight as to why the Daylight Code was not significant in Fresno as it had been in Capistrano, Seattle and Fort Collins.

We used multi-linear regression analysis to test a wide variety of variables to see which provided the best explanation of student performance. Of the variables describing the physical conditions of classrooms and schools, characteristics describing windows were generally quite stable in their association with better or worse student performance. Variables describing a better view out of windows always entered the equations as positive and highly significant, while variables describing, glare, sun penetration and lack of visual control always entered the models as negative.

In addition, attributes of classrooms associated with acoustic conditions and air quality issues followed a similar pattern. Those variables representing sources of internal noise, such as a loud HVAC system or a loud ballast hum from the lighting system, were consistently associated with negative student performance, while increasing the amount of carpet (which reduces acoustic reverberance) in the classroom was associated with better student performance in reading. Variables related to indoor air quality showed that in Fresno automatically controlled mechanical ventilation (No Teacher Control of Fan) was positive, while visible water damage or a surveyor assessment of musty air in the classroom was negative.

Summary of Study Findings

The findings of regression models in this study support the general conclusions that:

- The visual environment is very important for learning.
- An ample and pleasant view out of a window, that includes vegetation or human activity and objects in the far distance, supports better outcomes of student learning.
- Sources of glare negatively impact student learning. This is especially true for math learning, where instruction is often visually demonstrated on the front teaching wall. Per our observations, when teachers have white marker boards, rather than black or green chalk boards, they are more likely to use them and children perform better in math.
- Direct sun penetration into classrooms, especially through unshaded east or south facing windows, is associated with negative student performance, likely causing both glare and thermal discomfort.
- Blinds or curtains allow teachers to control the intermittent sources of glare or visual distraction through their windows. When teachers do not have control of their windows, student performance is negatively affected.
- The acoustic environment is also very important for learning. Situations that compromise student focus on the lessons at hand, such as reverberant spaces; annoying equipment sounds, or excessive noise from outside the classroom, have measurable negative effects on learning rates.
- Poor ventilation and indoor air quality also appear to negatively affect student performance. However, in FUSD these issues are almost hopelessly intertwined with thermal comfort, outdoor air quality and acoustic conditions. Teachers often must choose to improve one while making another aspect of the classroom worse.
- Physical characteristics of classrooms are just as likely to affect student learning as many other factors commonly given much more public policy attention. Variables describing the physical conditions of classrooms, most notably the window characteristics, were as significant and of equal or greater magnitude as teacher characteristics, number of computers, or attendance rates in predicting student performance.

Problems with Daylit Classrooms

We tested each statistical model with and without the Daylight Code. When we added the Daylight Code the other variables remained essentially the same, but the Daylight Code always came in as significant and negative, telling us that there was some characteristic of classrooms sorted by the Daylight Code that was associated with a negative effect. Examination of the performance of individual classrooms, considering all of their window characteristics plus the Daylight Code, showed that there were three types of classrooms in Fresno that were performing particularly well in relationship to their daylight characteristics—finger plan classrooms, grouped plan classrooms and portables—as long as they had no glare or other undesirable window characteristics. Thus, classrooms with both the highest and the lowest Daylight Code were seen to support better student performance.

Many potential explanations for the negative influence of the Daylight Code were considered, and we went back on site to see if there were any systematic reasons why students in classrooms with a higher Daylight Code would perform worse, or those in classrooms with a low Daylight Code would perform better. In this second phase of the study, detailed examination of a number of potential confounding variables, including view-related distractions, glare, operable windows, radiant thermal comfort, indoor air quality and acoustic performance were considered. To better understand the results of the regression analysis, we visited 40 classrooms while they were in operation and surveyed 116 teachers about their assessment of and operation of their classrooms.

Overall, the daylit classrooms in Fresno had some consistent problems that might have degraded student performance, and which we believe did not exist in the previous districts studied. The most compelling of these were the acoustic problems created in the daylit classrooms. We found the classrooms with high daylight codes to have reverberation levels above current national recommendations, while classrooms with low daylight codes typically met or exceeded those recommendations. This reverberation problem tended to be aggravated by the presence of teaching assistants who provide in-class tutorials for individuals or small groups. In low Daylight Code classrooms these tutorials were often held outside of the classroom in conveniently adjacent common areas, while in the high Daylight Code classrooms they took place in the back of the classroom, raising the background noise level and making the teacher's voice less intelligible.

In addition, we noted teachers in classrooms with a high Daylight Code were more likely to teach with their windows open, primarily to compensate for poor temperature control and to improve ventilation. These open windows allowed in more noise from the outside, exacerbated by crowded schools running on multiple lunch and recess schedules. We noted from the various regression models that, on the one hand, continuous mechanical ventilation seemed to improve student performance, while on the other hand, a higher percentage of operable windows were associated with lowered performance. We hypothesize that the poor outdoor air quality in Fresno [3], combined with the epidemic of asthma in school children, suggests the preferred use of mechanically filtered air rather than natural ventilation in FUSD.

We also considered whether the problems we detected with daylit classrooms could be rectified, and calculated the value of potential energy savings if daylit classrooms were operated to reduce reliance on electric lighting. Acoustic analysis of the daylit classrooms showed that the reverberance problem could be corrected with the use of more sound-absorbing surfaces, such as carpet and high quality acoustic tile. The use of dual pane low-e glazing on the windows could simultaneously improve both the acoustic conditions in the classrooms and thermal comfort. Energy analysis showed substantial potential savings (1.1 kwh/sf) for retrofitting existing FUSD daylit classrooms with photocontrols. California could achieve an additional 3300 to 4800 megawatthours (0.6 to 0.9 kwh/sf) of energy savings statewide for each year that all new school construction included good daylighting design with photocontrols. This would accumulate to 33,000 to 48,000 megawatthours per year savings after ten years.

The Importance of School Design Choices

These findings suggest the importance school planners should give to the architectural design of schools. The statistical models repeatedly demonstrate that physical condition of classrooms and schools are just as likely to affect student learning as many other factors commonly given much more public policy attention. Variables describing the physical conditions of classrooms, most notably the window characteristics, were as significant and of equal or greater magnitude as teacher characteristics, number of computers, or attendance rates in predicting student performance. The partial R2 of the different variable types is also very informative. The one variable which is specific to the individual—their fall test score—predicts about 10% of the variation in the gain from fall to spring. The demographic variables, which describe generic groups to which the individual belongs, predict performance with an order of magnitude less precise, or about 1% each. The physical characteristics of the schools again drop another order of magnitude in predictive power, each significant variable describing on the order of 0.1% of the variation in student performance.

However, even though the physical characteristics of classroom have a very minor potential influence on the performance of a given individual, they will reliably affect hundreds or thousands of students over the life of the building, typically 50 years. Since the design of classrooms is entirely within the control of the school district, much more so than student or teacher demographics, optimized design of schools should be a central concern for all new school construction.

Daylight and Retail Sales – CEC PIER 2003

This study presents evidence that a major retailer is experiencing higher sales in daylit stores than in similar non-daylit stores. Statistical models were used to examine the relationship between average monthly sales levels and the presence of daylight in the stores, while simultaneously controlling for more traditional explanatory variables such as size and age of the store, amount of parking, local neighborhood demographics, number of competitors, and other store characteristics. The retailer, who will remain anonymous, allowed us to study 73 store locations in California from 1999 to 2001. Of these, 24 stores had a significant amount of daylight illumination, provided primarily by diffusing skylights.

This study was performed as a follow-on to a similar study completed for Pacific Gas and Electric in 1999[4], which found that for a certain retail chain, all other things being equal, stores with skylights experienced 40% higher sales than those without skylights. This study, on behalf of the California Energy Commission, examined a second retail chain, in an entirely different retail sector, to see if the original findings would hold in a new situation, and if we could learn more about any daylight effect that might exist.

As a first step in this process, a simple model with daylight as a yes/no variable, and using basically the same format and inputs as the previous study, did not find a significant correlation between the presence of daylight, and increased sales. We then pursued the study in greater detail, adding more information to the model and describing daylight on a continuous scale by the number of daylit hours per year in each store.

The retailer in this study had a less aggressive daylighting design strategy and also more variation in both the range of daylight conditions and the range of store designs than the retailer in the first study. For this study, we collected much more detailed information about the characteristics of each store, and verified all information on site. Neighborhood demographics and retail competition were described using detailed, site-specific GIS analysis. Store managers were interviewed and employees were surveyed about their observations and preferences. For the final analysis, the amount of daylight in each store was described as the number of hours per year that daylight illumination levels exceeded the design electric illumination level.

Statistical regression models of average sales for the stores, using up to 50 explanatory variables, and both linear and natural log descriptions of the variables, found that increased hours of daylight per store were strongly associated with increased sales, but at a much smaller magnitude than the previous study. In addition, for this chain, the daylight effect on sales was found to be constrained by the amount of parking available at the store site. Sites with parking lots smaller than the norm experienced decreased sales associated with daylight, while stores with average and ample parking experienced increased sales as both the amount of daylight and parking increased. The statistical models were also more comprehensive, explaining about 75% of the variation in the data (model R2=0.75), compared to 58% in the previous study.

Specifically, this study found that:

- Average effect of daylighting on sales for all daylit stores in this chain was variously calculated from 0% to 6%, depending on the type of model and time period considered.
- A dose/response relationship was found, whereby more hours of useful daylight per year in a store are associated with a greater daylight effect on sales.
- No seasonal patterns to this daylight effect were observed.
- A bound of an empirical daylight effect for this chain was detailed, with a maximum effect found in the most favorable stores of about a 40% increase in sales. This upper bound is consistent with our previous finding.
- Daylight was found to have as much explanatory power in predicting sales (as indicated by the variable's partial R2) as other more traditional measures of retail potential, such as parking area, number of local competitors, and neighborhood demographics.
- Along with an increase in average monthly sales, the daylit stores were also found to have slightly smaller increase in the number of transactions per month.
- The retailer reported that the primary motivation for the inclusion of daylight was to save on energy costs by having photocontrols turn off electric lights when sufficient daylight was detected. The retailer has been very pleased with the resulting reduction in operating costs. Based on current energy prices we estimated average whole building energy savings for the daylit stores at $0.24/sf for the current design, with a potential for up to $0.66/sf with a state-of-

the art design.

- The value of the energy savings from the daylighting is far overshadowed by the value of the predicted increase in sales due to daylighting. By the most conservative estimate, the profit from increased sales associated with daylight is worth at least 19 times more than the energy savings, and more likely, may be worth 45-100 times more than the energy savings.
- During the California power crisis of 2001, when almost all retailers in the state were operating their stores at half lighting power, the stores in this chain with daylight were found to benefit the most, with an average 5.5% increase in sales relative to the other non-daylit stores within the chain (even while all stores in this chain increased their sales compared to the previous period).
- Employees of the daylit stores reported slightly higher satisfaction with the lighting quality conditions overall than those in the non-daylit stores. Most strikingly, they perceived the daylit stores to have more uniform lighting than the non-daylit stores, even though direct measurements showed both horizontal and vertical illuminance levels in the daylight stores to be substantially less uniform.
- Store managers did not report any increase in maintenance attributable to the skylights.
- The chain studied was found to be saving about $0.24/sf per year (2003 energy prices) due to use of photocontrols, which could potentially increase up to $0.66/sf per year with an optimized daylighting system.

Re-Analysis Report: Daylighting in Schools, Additional Analysis – CEC PIER 2001

This report is a follow-on study to the Daylighting in Schools study[5] that was completed in 1999, which found a compelling statistical correlation between the amount of daylighting in elementary school classrooms and the performance of students on standardized math and reading tests. This re-analysis of the original study data was intended to answer key questions raised by the peer review of the earlier study, and expand our understanding of methodological choices for further work.

The original findings potentially have very important implications for the design of schools and other buildings where people live, work and play. Daylight used to be common, and even required in schools, homes and offices, but fully daylit buildings became increasingly rare as electric lighting became more the norm. This re-analysis study helps to provide greater certainty for the original findings.

For this re-analysis study HMG conducted four tasks:

- The Teacher Survey collected information from a sample of teachers in the Capistrano school district about their education and experience levels, preferences for classroom features and operation of those features. The primary purpose of the survey was to provide input to a subsequent "assignment bias" analysis. In addition, we learned some useful information about teacher preferences, attitudes and behaviors in response to classrooms conditions.
- While the teachers we surveyed generally had a preference for windows, daylight and views in their classrooms, these preferences were not found to be driving classroom preferences. Far more important was an almost universal desire for more space, a good location, quiet, lots of storage and water in the classroom.
- Environmental control was also found to be an important issue for teachers, especially for those who did not have full control. Teachers seemed to hold a basic expectation that they would be able to control light levels, sun penetration, acoustic conditions, temperature and ventilation in their classrooms. They made passionate comments about the need for improvement if one or more of these environmental conditions could not be controlled in their classroom.
- The Teacher Bias Analysis further examined information from the Teacher Survey. The survey

data was coded into variables and statistically analyzed in relation to both assignment to daylit classrooms and the student performance models. The goal of the Bias Analysis was to discover if the original study had over-inflated the effect of daylight on student learning by not accounting for a potential "assignment bias" of better teachers to more daylit classrooms.

We conclusively found that there was not an “assignment bias” influencing our results. None of the individual teacher characteristics we identified were significant in explaining assignment to a daylit classroom in the Capistrano District. Considering all teacher characteristics together only explained 1% of the variation in assignment to daylit classrooms. We did find that a few types of teachers, those with more experience or honors, were slightly more likely (1%-5%) to be assigned to classrooms with more windows or some types of skylights.

When we added the teacher characteristics to the original student performance models, the daylight variables were not reduced in significance. Further analysis of other sub-populations repeated these findings. Among twelve models considered, we identified a central tendency of a 21% improvement in student learning rates from those in classrooms with the least amount of daylight compared to those with the most.

In the Grade Level Analysis, we re-analyzed the original student test score data for both Capistrano and Seattle by separate grade level, instead of aggregating the data across the four grade levels (2-5). Our goal was to determine if this method would more accurately explain the relationship of student performance to daylighting. We tested for statistical significance and correlation, and we looked at any patterns discovered in the analysis.

The data did not show any significant patterns between a daylight effect and the separate grade levels, neither an increase or decrease in daylight effects by grade level. Thus, we conclude that there do not seem to be progressive effects as children get older, nor do younger children seem to be more sensitive to daylight than older children. Allowing the results to vary by grade did not noticeably improve the accuracy of the models. Therefore, we conclude that looking at data across grade levels is a sufficiently accurate methodology.

In the Absenteeism Analysis, we used absenteeism and tardiness data in the original Capistrano data set as dependent variables and evaluated them against the full set of explanatory variables from the original study, plus the new information on teacher characteristics. These models would allow us to assess whether daylighting or other classroom physical attributes potentially impacted student health, as measured by changes in student attendance.

Student attendance data is certainly not the best indicator of student health. Yet to the extent that attendance data does reflect student health, our findings do not suggest an obvious connection between physical classroom characteristics and student health. Notably, daylighting conditions, operable windows, air conditioning and portable classrooms were not found to be significant in predicting student absences.

Overall, the strength of the daylight variable in predicting student performance stands out sharply across all of these re-analysis efforts.

This analysis also demonstrated that the findings of these models are more strongly dependent upon the sample population then the subtleties of the explanatory variables. Thus, we believe that it will be more informative to replicate this study with a different population, to continue to try to refine the models with further detail in the explanatory variables.

Daylighting in Schools – PG&E 1999

An Investigation into the Relationship between Daylighting and Human Performance

This study looks at the effect of daylighting on human performance. It includes a focus on skylighting as a way to isolate daylight as an illumination source, and separate illumination effects from other qualities associated with daylighting from windows. In this project, we established a statistically compelling connection between daylighting and student performance, and between skylighting and retail sales. This report focuses on the school analysis.

We obtained student performance data from three elementary school districts and looked for a correlation to the amount of daylight provided by each student's classroom environment. We used data from second through fifth grade students in elementary schools because there is extensive data available from highly standardized tests administered to these students, and because elementary school students are generally assigned to one teacher in one classroom for the school year. Thus, we reasoned that if the physical environment does indeed have an effect on student performance, we would be mostly likely to be able to establish such a correlation by looking at the performance of elementary school students.

We analyzed test score results for over 21,000 student records from the three districts, located in Orange Country, California, Seattle , Washington, and Fort Collins, Colorado. The data sets included information about student demographic characteristics and participation in special school programs. We reviewed architectural plans, aerial photographs and maintenance records and visited a sample of the schools in each district to classify the daylighting conditions in over 2000 classrooms. Each classroom was assigned a series of codes on a simple 0-5 scale indicating the size and tint of its windows, the presence and type of any skylighting, and the overall amount of daylight expected.

The study used multivariate linear regression analysis to control for other influences on student performance. Regressions were compared using data from two separate tests, math and reading, for each district. Each math and reading model was also run separately using first the window and skylight codes, and then the overall daylight code. We reasoned that if daylight effects were truly robust the variables should perform similarly in all models. Thus, we created a total of twelve models for comparison, consisting of four models for each of three districts.

The daylighting conditions at the Capistrano school district were the most diverse, and the data from that district were also the most detailed. Thus Capistrano became our most precise model. In this district, we were able to study the change in student test scores over a school year. Controlling for all other influences, we found that students with the most daylighting in their classrooms progressed 20% faster on math tests and 26% on reading tests in one year than those with the least. Similarly, students with the largest window areas were found to progress15% faster in math and 23% faster in reading than those with the least. And students that had a well-designed skylight in their room, one that diffused the daylight throughout the room and which allowed teachers to control the amount of daylight entering the room, also improved by 19-20% faster than those students without a skylight. We also identified another window-related effect, in that students in classrooms where windows could be opened were found to progress 7-8% faster than those with fixed windows, regardless of whether they also had air conditioning. These effects were all observed with 99% statistical certainty.

The studies in Seattle and Fort Collins used the final scores on math and reading tests at the end of the school year, rather than the amount of change from the beginning of the year. In both of these districts we also found positive, and highly significant, effects for daylighting. Students in classrooms with the most daylighting were found to have 7% to 18% higher scores than those with the least.

The three districts have different curriculum and teaching styles, different school building designs and very different climates. And yet the results of studies show consistently positive and highly significant effects. This consistency persuasively argues that there is a valid and predictable effect of daylighting on student performance.

The results of this study of student performance, when combined with the companion study showing the positive effect of skylighting on retail sales, also strongly support the thesis that these performance benefits from daylighting can be translated to other building types and human activities.

Skylighting and Retail Sales – PG&E 1999

An Investigation into the Relationship between Daylighting and Human Performance

This study looks at the effect of daylighting on human performance. It specifically focuses on skylighting as a way to isolate daylight as an illumination source, and avoid all of the other qualities associated with daylighting from windows. In this project, we established a statistically compelling connection between skylighting and retail sales, and between daylighting and student performance. This report focuses on the retail analysis.

We analyzed data on the sales performance of a chain retailer who operates a set of nearly identical stores. The analysis included 108 stores, where two thirds of the stores have skylighting and one third do not. The design and operation of all the store sites is remarkably uniform, with the exception of the presence of skylights in some. The electric lighting was primarily fluorescent. The skylights often provided far more illumination, often two to three times the target illumination levels. Photo-sensor controls turned off some of the fluorescent lights when daylight levels exceeded target illumination.

The monthly gross sales per store were averaged over an 18-month period that went from February 1 of one year to August 31 of the following year. This average sales figure was transformed into a "sales index" that we could manipulate statistically, but that did not reveal actual dollar performance. Stores in the sample were selected to operate within a limited geographic region that had similar climatic conditions, and to have a constrained range of size and age. The geographic region has a relatively sunny climate. All of the stores in the data set are one story.

The multivariate regression analysis allowed us to control for the influence of other variables, which might influence sales. Other variables considered included the size and age of the store, hours of operation, and economic characteristics associated with the zip code location.

Skylights were found to be positively and significantly correlated to higher sales. All other things being equal, an average non-skylit store in the chain would be likely to have 40% higher sales with the addition of skylights, with a probable range somewhere between 31% to 49%. This was found with 99% statistical certainty. After the number of hours open per week, the presence of skylights was the best predictor of the sales per store of all the variables that we considered. Thus, if a typical non-skylit store were averaging sales of $2/sf, then its sales might be expected to increase to somewhere between $2.61 to $2.98 with the addition of a skylighting system.

The skylights are seen to have a major impact on the overall operation of the chain. Were the chain to add the skylighting system to the remaining 33% of their stores, their yearly gross sales are predicted to increase by 11%. The difference between having none of their stores skylit and all their stores skylit is a 40% increase in gross sales for the retail chain.

Footnotes:

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[1] Heschong Mahone Group (1999). Daylighting in Schools. An investigation into the relationship between daylight and human performance. Detailed Report. Fair Oaks , CA.

[2] Heschong Mahone Group (2001) Re-Analysis Report, Daylighting in Schools, for the California Energy Commission, published by New Buildings Institute, www.newbuildings.org

[3] Fresno has nationally high levels of small particulate pollution associated with lung damage, per J Raloff "Air Sickness" in Science News, Vol 164, No 5.

[4] Heschong Mahone Group (1999). Skylighting and Retail Sales. An investigation into the relationship between daylight and human performance. Detailed Report for Pacific Gas and Electric Company. Fair Oaks , CA .

[5] Heschong Mahone Group (1999). Daylighting in Schools. An investigation into the relationship between daylight and human performance. Detailed Report. Fair Oaks , CA.

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EPI BRIEFING PAPER
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GOOD BUILDINGS, BETTER SCHOOLS
An economic stimulus opportunity with long-term benefits

BY MARY FILARDO

The nation's 97,000 public school buildings comprise an estimated 6.6 billion square feet of space on over 1 million acres of land. And while states and local communities invested over $500 billion in K-12 school building improvements from 1995 to 2004, considerable additional investments are needed to ensure that the nation's public schools are healthy, safe, environmentally sound, and built and maintained to support a high-quality education.

Today, many of the nation's schools face the combined challenges of deteriorating conditions, out-of date design, and changing utilization pressures (including intense overcrowding in some communities and rapidly declining enrollments in others). These combined deficiencies impair the quality of teaching and learning and contribute to health and safety problems for staff and students. Building design and facility conditions have also been associated with teacher motivation and student achievement.

Economic conditions in the United States have prompted serious discussions about the need for federal

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TABLE 1

Estimate of total U.S. K-12 public school building square footage

Grade level	Enrollment fall 2007 (projected)	Estimated gross building square feet per student	Total estimated school building square feet
Elementary	34,592,000	120	4,151,040,000
Secondary	15,018,000	165	2,477,970,000
Total	49,610,000		6,629,010,000

SOURCE: 21st Century School Fund.

stimulus spending. In this context, the deteriorating physical condition of the nation's public schools actually presents an opportunity for federal spending that is targeted to near-term growth, by creating high-quality jobs, and that provides long-term benefits by building a better learning environment. A $20 billion maintenance and repair initiative could eliminate years of deferred maintenance, particularly in schools in low-income communities. It could also generate 250,000 skilled maintenance and repair jobs and supply $6 billion of materials and supplies. Another federal investment—$50 billion in capital funds for the lowest-income school districts—would be targeted, timely, and temporary and address the inequity in capital outlays of the last decade. Finally, an ongoing federal role in capital funding, comparable to the federal share in operating funding of approximately 10% of state and local spending, would help ensure that one of the nation's most important enterprises—the education of its children—has the facilities to generate dividends.

The scale of public school infrastructure in the U.S.

In fall 2007, approximately 49 million students were enrolled in about 97,000 public schools.[1] No national inventory or assessment of K-12 public school buildings is available in the United States, and not all states maintain an inventory of basic information on the size, age, condition, or capacity of their public school buildings. An estimate of the total amount of space in the nation's public schools, prepared by the 21st Century School Fund using projected public school enrollment for the fall of 2007 and average space standards for school buildings, is shown in **Table 1**. The estimate assumes 120 or 165 gross square feet per student, depending upon grades offered, for a total of 6.6 billion gross square feet for the nation's 97,000 public schools.[2]

In addition to building space, schools also utilize extensive land and site amenities such as roads, parking, lighting, sidewalks, storm water management systems,

TABLE 2

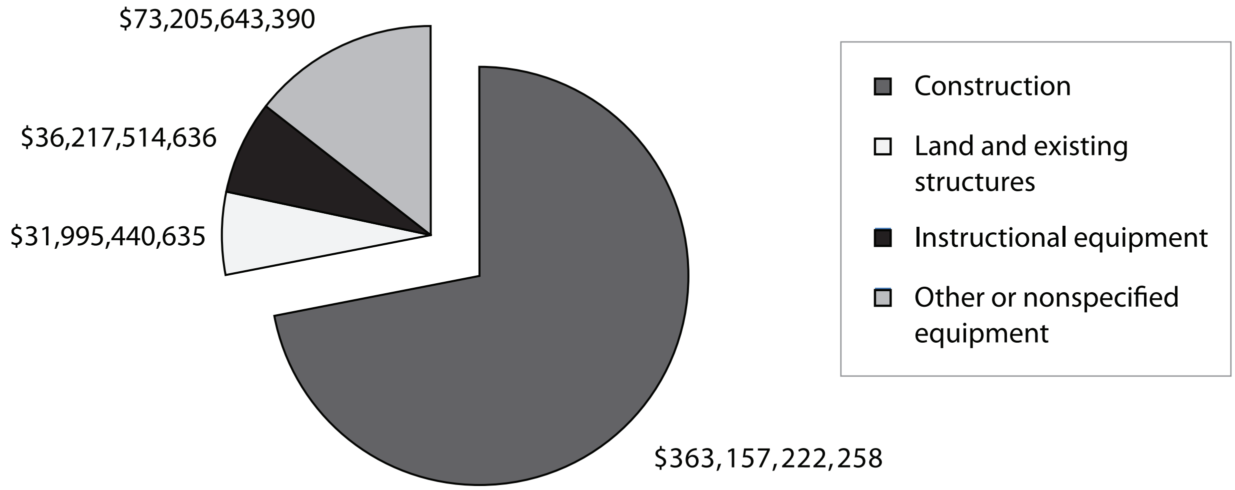
Estimate of total acreage in U.S. K-12 school sites

Grade level	Number of public schools 2005-06	Average acres per school	Total estimated acreage
Elementary	67,291	10	672,910
Secondary	23,800	15	357,000
Combined & other	6,291	15	94,365
Total	97,382		1,124,275

SOURCE: 21st Century School Fund.

FIGURE A

Public school capital outlays ($2005)



SOURCE: U.S. Census of Governments 2006.

athletic fields, recreational areas, and green space. Using a similar approach to estimate the total land area utilized by public schools yields a conservative estimate of over 1 million acres (**Table 2**).[3]

Another indication of the size of the public school inventory is the capital outlay reported in the U.S. Census of Governments. During the 1995-2004 period, the combined expenditures for K-12 school building improvements—including new construction, renovation, major maintenance and repairs, land, and equipment—were approximately $504 billion (**Figure A**). Over 85% of these capital expenditures were facility related.

Deteriorating conditions in the public schools

Like basic inventory on school buildings and land, assessments of building and site condition, design, and utilization are also not available at the national level and are not readily or universally available at the state level. The National Center for Education Statistics, in its congressionally mandated report *The Condition of Education,* includes no information about the condition of elementary and secondary public school building infrastructure.

The management of school facilities is a local responsibility, but one that local communities and school districts are struggling to meet. However, evidence abounds that, even after over $500 billion of capital outlays in the decade between 1995 and 2004, public school facilities, particularly in low-wealth communities, have substantial deficiencies.

In 31 states, plaintiffs have challenged the adequacy or equity of public education funding in low-income communities and have made facility conditions an element of their lawsuits. In four states, the condition of facilities was the exclusive focus of the suit (Education Law Center 2006). Another indicator that serious building deficiencies are the norm rather than the exception is the American Society of Civil Engineers report card on infrastructure. The society began including public schools in its infrastructure report card in 1998; in that year it gave public schools an F, followed by a D- in 2001 and 2003, and a D in 2005. While this is progress, as one would hope after a half-trillion dollar investment during 1995-2004 the still-low overall grade indicates how great the needs were in 1995 and how challenging it is to keep up with building maintenance, lifecycle replacements, new educational design, and enrollment change. And, of course, the overall national grade says nothing about how badly certain states and localities are failing.

Substandard conditions, design, and utilization take many forms. Poor school design and facility conditions can lead to "sick building syndrome," according to the Environmental Protection Agency (EPA 2000). Two-thirds of teachers in the District of Columbia reported poor air quality in their classrooms (Schneider 2003). The General Accounting Office (GAO 1995) found that one in five students nationwide attends a school that suffers from poor ventilation; poor ventilation can boost rates of asthma and respiratory illness, both of which are disproportionately observed in urban schools (EPA 2000). The temperature and humidity in classrooms can affect children's health and motivation. One study of Florida classrooms found many with mold growing inside ceilings, triggering allergic symptoms (Bates 1996).[4]

Public school districts face problems not only with the basic condition of their buildings, but also with the need to modernize old or obsolete building design.

- Early childhood education, which has expanded from a half-day of kindergarten to full-day programs for three-year-olds, particularly in school districts serving low-income families, requires changes in classroom design. Early childhood classrooms need bathrooms, special furniture, easy access to the out-of-doors, more space for adults, and more space for gross motor play.

- Technology should be ubiquitous for instruction, security, and administration. School buildings need voice, video, and data highways throughout their facilities and electrical upgrades to support the computers, audio-enhanced classroom technology, smart boards, and other classroom technology aids that have the potential to help close achievement gaps and improve the basic quality of teaching and the productivity of teachers. Among the cohort of students who can benefit most from education technology are special needs students.

- Science education would benefit from facility-related improvements, whether for safety or for quality. The National Science Teachers Association (NSTA) recommends that students spend 50% of their time in hands-on, inquiry-based science. In their guide to planning science facilities, the NSTA states: "Good science programs require the uniquely adaptable learning space we call a laboratory, as well as access to both indoor and outdoor space for research, environmental studies, and reflection. Yet the vast majority of communities moving toward the Standards will find their progress limited by the facilities available in their schools" (Motz et al. 2007).

In addition to condition and design challenges, many school districts face either increasing or declining enrollments that require them to either build new inventory or reduce inventory to meet their changing demographics. Fully half of the $363 billion spent on school construction over the 1995-2004 decade was to address enrollment increases (Filardo et al. 2006). Ten thousand schools were added to the nation's public school inventory between 1995 and 2005.

How is the quality of public school facilities important?

In a March 2008 report on improving California's infrastructure, authors Dowall and Ried describe infrastructure in terms of the public benefits it brings. So rather than thinking of infrastructure in terms of transit, roads, bridges, and waterways; reservoirs, water supply, and sewers; landfills, parks, and other public lands; schools, colleges, and universities; and prisons, jails, and courts, they describe it in terms of the services this infrastructure supports—"mobility; safe and reliable sources of water; sustainable development; knowledge creation and transfer; and personal security." This perspective is important to a discussion about school infrastructure, because the issue is not the buildings themselves, but what we need them for—in the case of public schools, for knowledge creation and transfer.

Public school districts need to improve the quality of education so that coming generations make greater progress against international and domestic conflicts, poverty, disease, and the degradation of the environment. School districts need to graduate students who will successfully compete globally, and they need to close the achievement gaps between children from advantaged and disadvantaged cohorts to achieve this goal. *Public Schools and Economic Development: What the Research Shows* (Weiss 2004) examines research linking educational investment to national productivity and correlating educational quality and quantity to wages, productivity, and social equity. It concludes, "Taking the research as a whole—including studies focused on both domestic and international data, as well as various theories discussed—the findings strongly indicate that a nation's educational system helps determine the quality of its labor force and therefore the health of its economy."

Many of the key educational initiatives designed to give the nation's children the tools and knowledge they need for the future have facility-related implications. Building deficiencies impair the quality of teaching and learning and contribute to health and safety problems of staff and students. Building design and facility conditions have also been associated with teacher motivation and student achievement. For example, classroom lighting and thermal comfort are commonly cited by teachers as determinants of their own morale and the engagement of their students (Corcoran, Walker, and White 1988; Jago and Tanner 1999). Lemasters (1997) identified 53 studies that linked design features to student achievement.

Two studies (Lewis 2000; Buckley, Schneider, and Shang 2004)—one in Los Angeles and the other among Milwaukee schools—directly observed school conditions and controlled for pupil and neighborhood socioeconomic characteristics, school size, and students' reported motivation levels. Facility conditions and maintenance variables included conditions of lockers, visible graffiti, and frequency of cleaning classrooms. The studies found higher reading scores among elementary and high school students in better-maintained schools, after accounting for the other influences.

While the quality of public school buildings is most essential for the school-age population that is compelled to attend school and the over 6 million teachers and other adults who work in schools and school districts, these community-based facilities can and often do serve a much wider community. They are a public commons in many communities, accessible for public meetings, voting, and emergency shelters, as well as for use by private community groups and organizations that might have programs or services after school hours. Public school buildings, which are among the most common public buildings, often define and anchor neighborhoods and communities.

What can investment in K-12 public school facilities do?

Immediate spending on public school maintenance and repair can benefit the economy and at the same time improve education quality and even health. Capital investment that will affect a two- to five-year economic future will improve schools and communities and create lasting benefit to society, particularly if this capital investment is used to help close the achievement gaps between low-income students and their more-affluent peers.

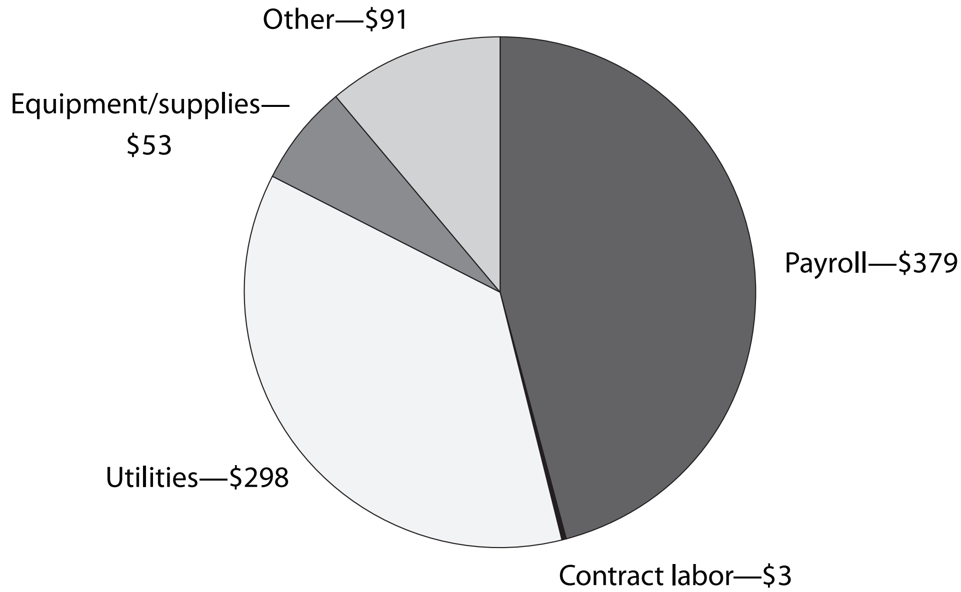
Reduce the backlog of maintenance and repairs

School districts must maintain their school buildings on an annual basis. The Maintenance and Operations Cost Study, which is developed based on surveys of school business officials, estimates the per student spending on maintenance and operations for the 2006-07 year at $824 per student, approximately 9.2% of total district operating expenditures (**Figure B** breaks this total down to its individual components). Using this per-student estimate, total maintenance and operations spending nationally for the 49 million public school students would be approximately $40 billion for the 2006-07 year. Excluding utilities, the expenditure would be approximately $26 billion.

Maintenance and repair as well as custodial and budgets are often underfunded, and maintenance is often deferred over a period of years. For example, the Portland Public Schools estimate an $800 million deferred maintenance backlog and the Los Angeles Unified School District estimates a $5 billion backlog in their existing facilities. Particularly given rising utility costs, basic building cleaning, expanding early childhood education, and the pressure to reduce class sizes, maintenance and repair are cut back to address other demands on school district budgets. The overall percentage of school district spending on maintenance and operations declined from 12.75% in 1988 to 7.58% in 2006; it rose to 9.19% in 2007, largely due to rising costs of utilities (Agron 2007).

FIGURE B

Maintenance and operations expenditures per student, 2006-07



SOURCE: Agron 2007.

A $20 billion, one-time federal contribution to school districts to eliminate some of their deferred maintenance could generate close to 250,000 skilled maintenance jobs with nearly $6 billion for materials and supplies.[5] Maintenance and repairs at schools will improve health, help retain students and teachers in the school, and make the school environment more conducive to high-quality teaching and learning.

Reduce disparity in overall building quality

Schools in districts with a higher proportion of low-income children had less funding for new construction, renovations, and major maintenance and repairs than schools with more affluent student populations (Filardo et al. 2006). As is illustrated in **Figure C**, schools in districts where more than 75% of the students were eligible for free or reduced-price lunch, had, on average, only $4,800 per student invested in school construction over the 10 years between 1995-2004. Over the same period, the most affluent schools, where less than 10% of students were eligible for free or reduced lunch, had $9,361 invested in school construction.

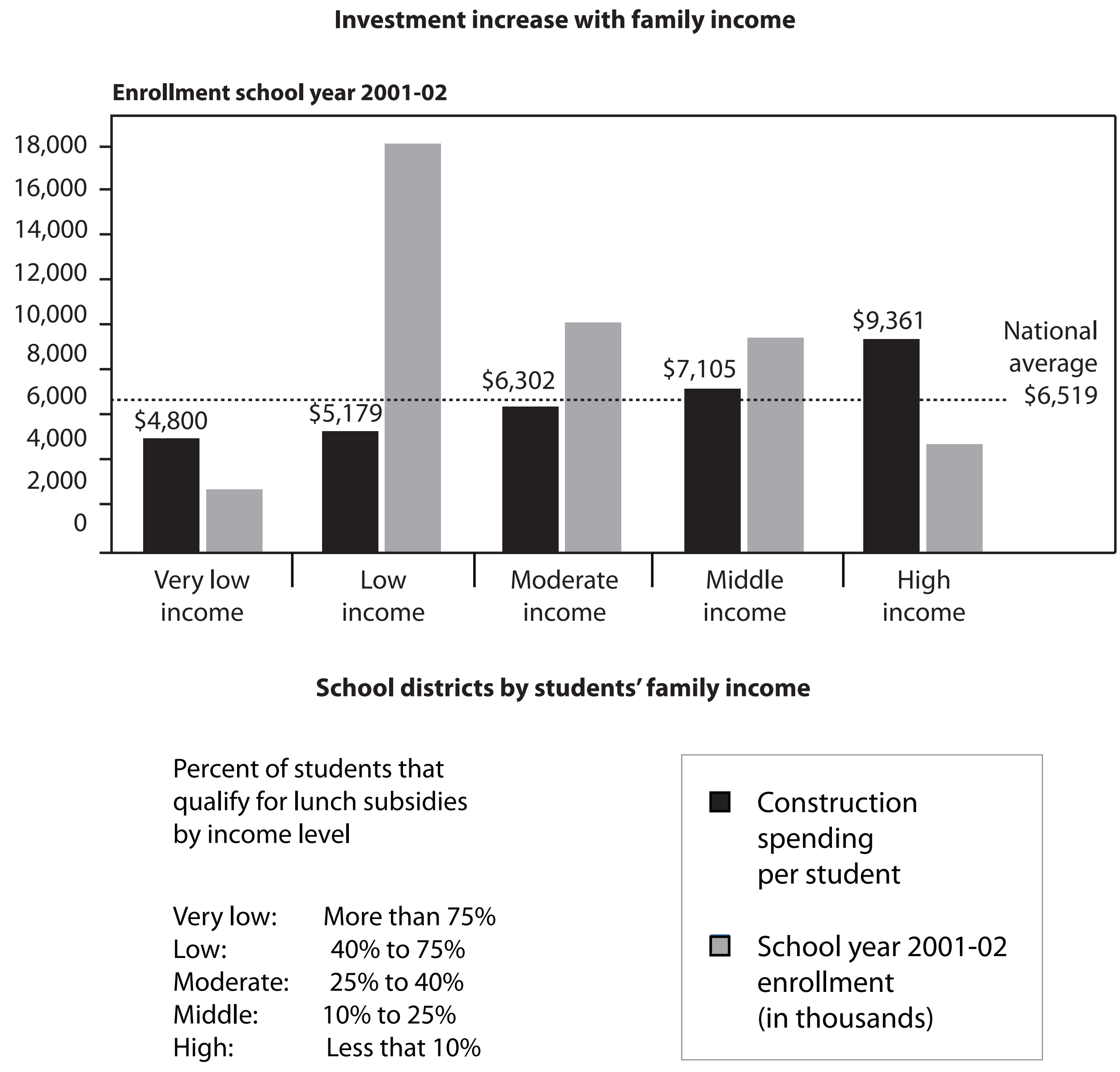
To bring the very low-, low-, and moderate-income districts up to parity with the middle-income districts would require additional funding for these districts of about $50 billion. Funding all districts to the level of the highest income districts would require nearly $140 billion. Targeted funding for major capital improvements can reduce disparity and help low-wealth districts close the achievement gap.

Establish a federal commitment to on-going facility funding for school districts serving low-wealth communities

Targeted, timely, and temporary help for states and school districts will help them eliminate building deficiencies in elementary and secondary public school buildings and eliminate the disparity that characterized school construction capital improvements during the previous decade. However, the federal government needs to play an ongoing role in school construction. While the need for an economic

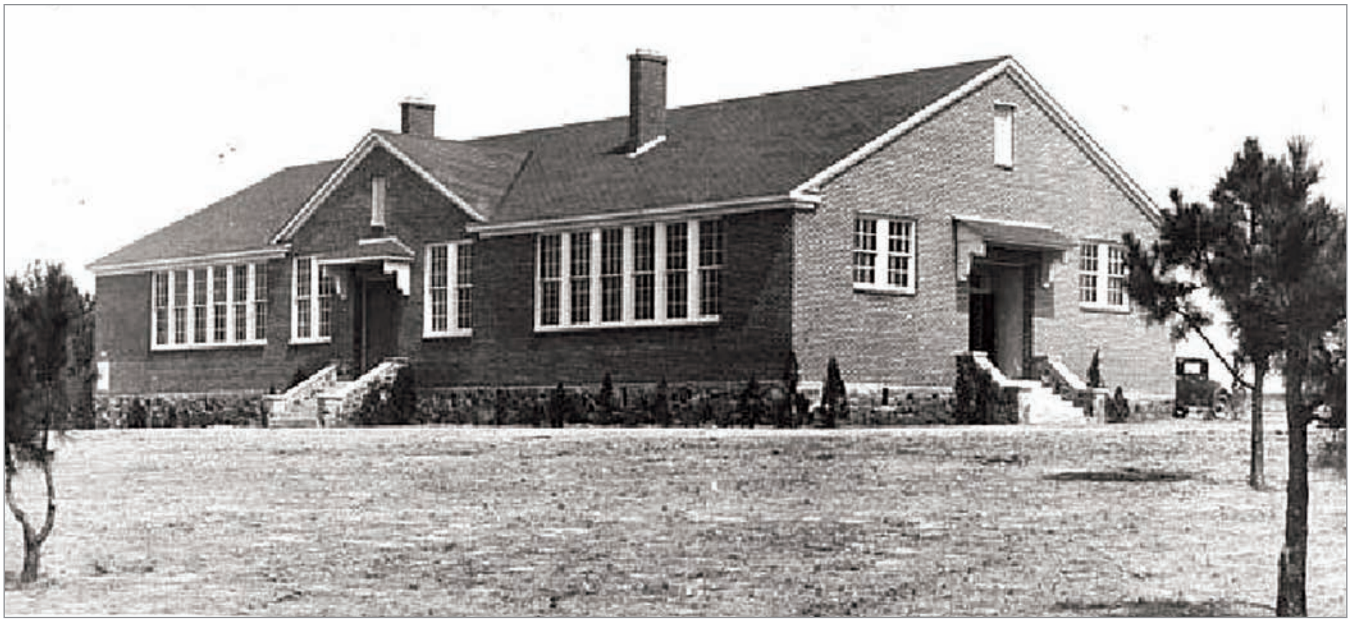
FIGURE C

School construction per student, 1995-2004, by school district levels of free and reduced lunch



SOURCE: Filardo et al. 2006.

stimulus is contributing anew to discussions about federal funding for public school facilities, the federal government has had a major role in public school construction before. Between July 1933 and March 1939, the Public Works Administration (PWA) funded the construction of more than 34,000 projects, including thousands of public buildings. Seventy percent of the new schools built during these seven years were paid for by the PWA.[6]



Eleanor Roosevelt School, 1938, a PWA-financed school in Warm Springs, Ga.

Federal funding of school construction should not just be a tool of economic stimulus, but it should also be part of the long-term responsibility of the federal government to ensure that school districts, particularly those with high proportions of low-income, special education, and English-language learners, have adequate resources to provide appropriate schooling. Just as the federal government contributes, on average, 10% of local school district operating budgets, the federal government should provide a comparable amount for capital. Using the $504 billion from the 1995-2004 period as a basis for establishing local and state effort plus the $85 billion that the states and local school districts paid in borrowing costs over the period, would translate to a 10% federal contribution of $5.89 billion per year.

Public education—including the built infrastructure to support it—is key to the economic prosperity of our communities and nation. Responsible management and investment in public school buildings pays three times: once for skilled jobs in local communities; a second time in the quality that healthy, safe, and educationally appropriate buildings create for students and their teachers; and finally, a third time in the benefits that quality education will reap for generations to come.

*—**Mary Filardo** founded 21st Century School Fund in 1994 to provide the District of Columbia and other urban communities with leadership, innovative financing solutions, research, and public policy analysis of school facility issues. She is a leading national authority on school facility planning, management, and financing, and she has written extensively on these public school facility issues. She serves on the Advisory Boards of the National Clearinghouse for Educational Facilities, Save Our Schools New Orleans, and the Center for Cities & Schools at the University of California, Berkeley. She is also a member of the International Program Advisory Board of the Public Education Network and the national jury for the Richard Riley Award for Schools as Centers of Community.*

Endnotes

1. National Center for Education Statistics, 2007 Digest, Table 2; number of schools is the latest reported by NCES for 2005-06.
2. To give an idea of how this GSF estimate compares to actual state or school district standards, the District of Columbia uses 140 GSF per student at the elementary level as a space standard, Massachusetts uses 145 to 180 GSF, and Utah uses 72 to 125 GSF.
3. School site sizes can vary tremendously depending upon whether they are located in central cities, suburbs, or rural areas, as well as by school size, and these estimates are extremely conservative. The recommended size, for example, in Montgomery County, Md. for a high school of 1,500-2,000 students is 40 acres. The average high school site size for high schools in the District of Columbia is 10 acres.
4. Similar detrimental health effects have been reported by Bates (1996) and Jago and Tanner (1999), as well as Boese and Shaw (2005), in a study conducted for the New York State Department of Education
5. An average maintenance salary for 2007 of $42,311 per year, with a 28% add-on for benefits, works out to an annual salary of $54,158.
6. Eleanor Roosevelt Papers Project, George Washington University, Department of History; Public Works Administration; www.gwu.edu/~erpapers/teachinger/glossary/pwa.

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Section 2

Highlights of High Performance School Design

High performance schools lead to higher performing students. The key highlights of high performance schools discussed in Section 2 relate to learning and student performance and include:

- Walking to School
- Healthier Children, Happier Teachers, A Smarter Society
- Increased Comfort and Savings

Achieving these qualities in school design should be a central focus for school board in setting direction for school facility design.

2.1 Walking to School

Perhaps no image evokes stronger feelings of nostalgia than those of walking to school. It is the basis of many astounding stories of older generations and their amazing feats of braving the elements and great distances by foot. Tales from grandparents and parents alike shaped a generation of children who presumed they were lucky because they did not have to walk to school.

It has been only a few generations since the majority of students were able to walk to school. Today fewer than one out of eight students walk to school. Considering both hard costs and social costs, the benefits of being able to walk to school are numerous.

According to the National Trust for Historic Preservation, schools historically were at the heart of American communities. When schools are the anchors within a neighborhood, both the students and residents benefit. Educational facility design that focuses on building shopping mall-sized schools outside of town alienates students, encourages sprawl, and impairs the sense of community. Students are better served by revitalizing historic neighborhood schools. Community integrated schools are responsible, thoughtful and fiscally sound. They become sources of great community pride. Students, parents and community members all have a vested interest in schools that are also neighbors.

Community integrated schools can result in lower transportation costs and better learning opportunities. The cost of student transportation continues to grow, as do the costs to parents in meeting the transportation demands of students for extracurricular functions. Dependency on parents for rides to and from schools was a top concern for students surveyed at a recent schools conference.

Community integration enhances the likelihood that schools will be located within walking distance. Locating schools within a comfortable distance of the population center makes it possible for a greater number of students to walk to their school. The location and design of community-integrated schools is related to student age. Neighborhood-based primary schools make sense where it is possible for small children to walk safely from their homes — ideally no further than a few blocks. Such schools allow children to stay in the safety of the family setting while experiencing the larger community for the first time. High schools with their need for playing fields of varying size need to be planned to serve the larger community by being placed adjacent to the commercial center of a community.

Fig. 2.1 Walking to school

Learning opportunities are often limited by student transportation logistics and cost. Community integrated schools are located within close proximity to a range of community resources that makes learning outside of the school walls affordable and more frequent. These include formal or informal learning experiences with local businesses and institutions. They also incorporate use of facilities that are under-used during regular school hours such as auditoriums, museums and sports facilities.

Locating schools within walking distance should be a primary goal of high performance school design.

2.2 Healthier Children, Happier Teachers, A Smarter Society

Next to involved parents and inspiring teachers, school buildings may have the greatest impact on student achievement and ultimately, social and economic well being.

The relationship between learning outcomes, children's health and school buildings is receiving increasing attention. The quality of design and the conditions of school buildings directly affect student performance and teacher satisfaction. Enhanced student performance and health are the reasons to place indoor air quality and daylighting as primary focuses of school building design. It's common sense. No one expects a plant to grow without fresh air and daylight. Yet schools continue to be built without providing effective daylighting and only partial attention is paid to what it takes to continually provide fresh and clean air.

Research shows that students in substandard buildings score up to 11 percentile points lower on achievement tests than students who learn in buildings designed with their health in mind. The quality of space and air directly affect the ability of students and teachers to concentrate. Effectively daylit schools are the foundation of better learning environments. Daylight leads to higher student test scores in math and reading. Pacific Gas & Electric commissioned a study in 1999 to look at the relationship between daylighting in schools and student academic performance. "Controlling for all other factors, we found that students with the most daylighting in their classrooms progressed 20% faster on math test and 26% on reading tests in one year than those with the least." Another study completed in 1992 by the Alberta Department of Education found that increased exposure to daylight results in increased attendance (by 3.5 days/year), 10% less tooth decay, greater physical growth and increased concentration levels due to significant reductions in noise from the buildings mechanical equipment.

High performance schools should have 100% daylighting and 100% fresh air for all spaces occupied by people.

Fig. 2.2 Healthier Children, Happier Teacher, a Smarter Society

2.3 Increased Comfort and Savings

The focus of high performance schools is to improve learning outcomes by improving the built environment. Yet, there are two additional benefits that result: increased comfort and financial returns. Both of these benefits further enhance the learning experience. First, high performance schools help students pay attention and stay alert as a result of having less noise, more daylight and fresher air. Second, resources saved as a result of more efficient and durable buildings can be invested in learning.

Comfortable spaces that provide appropriate conditions for learning require many components. These include pleasing aesthetic qualities, minimal fluctuations in temperature, appropriate levels of humidity and an appropriate acoustical environment for teaching. Building design that looks to natural more integrated solutions is the key difference from traditional mechanically intensive systems. Lighting design for example, can make efficient and effective use of daylighting during the day and artificial lighting at other times. Glare free lighting should be sufficient for blackboards, whiteboards and computer screens. Controlling lights by zones allows for greater regulation and less energy use. Integrated design solutions combine natural ventilation with mechanical systems, providing fresh air and energy savings and are based on having operable windows in all spaces occupied by people.

Fig. 2.3 Increase Comfort & Savings

Durability is another important factor in making decisions on new school buildings. Buildings can be built to last for next 100 years; however, 100-year buildings require a plan for integrating the components that will need to be replaced sooner. Start by setting high quality standards. You get what you pay for and buildings are no exception. Investing in high quality systems and materials quality materials can lead to lower lifecycle costs. Often the cost for labor to repair and replace poor quality systems and materials is greater than any increase in initial investment costs due to better quality.

Facility staff serves an important role in predesign. Typically they know more than anyone else about the use and performance of the school buildings. Making the routine maintenance jobs of facility staff easier for them to complete results in freeing up time to do the periodic maintenance jobs that are often left undone. Such deferred maintenance requirements lead to building system failure and costly emergency repair.

Simpler mechanical systems are preferred by facility staff, require less outside assistance and use less energy. High performance schools make simplicity a focus of design.