Sustainable K-12 Schools

By

Stephen Olson

Jenny Carney

Leonardo Academy Inc.

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Contact Information

Leonardo Academy Inc.
Michael Arny, President and Executive Director
Telephone: (608) 280 0255
Fax: (608) 255 7202
Email: info@leonardoacademy.org
Address: 1526 Chandler Street, Madison, Wisconsin 53711
Web: http://www.leonardoacademy.org

Stephen Olson is Director of Finance and Operations for Leonardo Academy Inc.
Jenny Carney is an Energy and Environmental Specialist for Leonardo Academy.

Leonardo Academy focuses on using integrated thinking to promote environmental sustainability. Leonardo Academy develops innovative, outcome-focused products and resources that facilitate sustainability by integrating economics, policy, and ecology. Leonardo Academy produces rating systems, certification programs, educational resources and other tools that make practicing sustainability practical. Leonardo Academy is a charitable (501c3) nonprofit organization.

Leonardo Academy's Cleaner and Greener Program develops and delivers tools that promote, facilitate and measure environmental sustainability. The program specializes in developing action plans and resources, and evaluation systems that enable organizations, institutions and individuals to reduce their impacts on the natural environment.

Executive Summary

Tightening school budgets, rising energy costs, and increased standardized testing have increased the pressure on K-12 school administrators who are trying to maintain, or better yet, raise student achievement levels in the face of decreased funding and deteriorating school facilities. Fortunately, there is a solution that alleviates all these concerns: sustainable high performance buildings. Studies show a direct causal relationship between sustainable high performance buildings and higher student achievement.

Sustainable building is a fully integrated, "whole building" approach to design, construction, renovation, and operation. This approach differs from the traditional design/build process, with the design team closely examining the integration of all building components and systems and determining how they best work together to save energy and reduce environmental impacts both during construction and throughout the operating lifetime of the building. Consideration must be given to site selection, architectural design, building method and materials, and landscaping practices for both new buildings and those undergoing improvements.

Sustainable schools, also referred to as *green* or *high performance* schools, benefit the outdoor environment, the indoor environment, and the students, teachers, and administrators who study and work in them. These schools are energy and water efficient and make use of renewable energy and green materials to the fullest extent possible. They provide environmental benefits by conserving natural resources and reducing pollution and landfill waste. Sustainable schools have also proven to be cost neutral or only slightly more expensive in upfront costs compared to traditional construction, and are much less costly to operate over the life of the building. This is vital in times of ever-tightening budgets and the current climate of large federal and state budget deficits.

Sustainable building practices provide optimally safe, healthy, comfortable, and productive learning environments for students and pleasant working environments for faculty and staff. Students who are uncomfortable or distracted by suboptimal building conditions are less able to learn. It only makes sense: a safe, healthy, comfortable environment for students, teachers, and staff will benefit student performance.

Several elements of sustainable building design and operations have direct effects on student performance. These elements include daylighting, thermal comfort, indoor air quality, and acoustics. Studies repeatedly show that better indoor environmental quality in schools results in healthier students and faculty, which in turn results in lower absenteeism and further improves student achievement. Daylighting in schools has also been proven to aid student performance. Sustainable design, by definition, makes use of daylighting principles and helps improve all aspects of indoor environmental quality, thereby preventing the conditions related to sick building syndrome and other building-related illnesses that diminish learning potential.

This paper examines the benefits of sustainable buildings and their impact on educational achievements in K-12 schools and provides information and strategies for greening both new and existing schools.

Introduction

School districts are simultaneously confronting the challenges of growing enrollments and ballooning energy costs. Add to this the prominence in the news of mold infestations and ensuing lawsuits, rising asthma rates, growing concerns about fitness levels and other health issues, plus the environmental concerns associated with constructing and operating buildings, and it is no surprise that green building strategies are becoming an increasingly compelling solution for addressing a host of issues.

School buildings are inextricably tied to the educational achievement of the populations they house, with new research elucidating an ever-growing understanding of the ties between indoor environmental quality and other building issues with student performance. Studies show both qualitatively and quantitatively that highly-efficient, well-maintained buildings deliver more stable and reduced operating costs along with superior learning environments. Given the significant consequences in regards to long term expenses and students' ability to learn, it is imperative that school administrators, policy makers and the public understand and seize opportunities to improve student health and performance through sustainable building design and operation.

An Overview of K-12 Schools

Nearly one in five Americans spend their days in elementary and secondary schools, with enrollment figures increasing every year. In 2001, 54 million American schoolchildren attended public and private K-12 schools with another 3.5 million teachers educating them. Jumping by 19 percent between 1988 and 2001, the rise in enrollment is expected to continue, with an estimated 56.3 million students filling our schools by 2013.[1]

Despite a growing understanding of the benefits of high performance facilities, the condition of America's school facilities varies widely, with few performing at the optimal levels needed to boost student performance. The last comprehensive assessment of school buildings took place in 1999, when the Federal government took stock of the nation's K-12 facilities through survey questionnaire data provided by 903 public elementary and secondary schools.[2]

Although most schools were found to be in relatively good condition, 1999 survey results indicated that:

- Seventy-five percent of schools need to make repairs, renovations, and modernizations to achieve good overall condition.
- An estimated $127 billion is needed to bring all schools into good overall condition.
- One in four school sites include at least one type of building in less than adequate condition.
- 11 million students are enrolled in schools with at least one type of onsite building in less than adequate condition.

[1] U.S. Department of Education, National Center for Education Statistics. October 2003. *Projections of Education Statistics to 2013*: Table 1. Enrollment in grades K-8 and 9-12 of elementary and secondary schools, by control of institution, with projections: Fall 1988 to Fall 2013. 5 January 06 <http://nces.ed.gov/programs/projections/tables/table_01.asp>

[2] U.S. Department of Education, National Center for Education Statistics. June 2000. *Condition of America's Public School Facilities: 1999.* NCES 2000-032, by Laurie Lewis, Kyle Snow, Elizabeth Farris, Becky Smerdon, Stephanie Cronen, and Jessica Kaplan. Bernie Greene, project officer. Washington, DC: 2000.

- Forty-three percent of schools have unsatisfactory performance in at least one of six environmental factors (lighting, heating, ventilation, indoor air quality (IAQ), acoustics/noise control, and physical security of buildings).
- Ventilation is the environmental condition most likely to be unsatisfactory (26 percent of schools); 20 percent of schools experience unsatisfactory conditions in the areas of heating, IAQ, acoustics/noise control, and physical security; lighting conditions are unsatisfactory in 12 percent of schools.
- The average age of instructional buildings in 1999 was 40 years, based on years since original construction.
- The average functional age of instructional buildings in 1999, based on the year of the most recent renovation or construction if no renovation occurred, was 16 years.
- The functional age of schools was found to be correlated to their conditions, with older schools more likely to report inadequate or unsatisfactory conditions.
- Schools with the highest concentration of poverty are more likely to report unsatisfactory environmental conditions than those with the lowest concentration of poverty.
- About twenty-five percent of schools are overcrowded, based on the capacity of permanent instructional buildings and space.

Based on this 1999 data, most of America's public schools are considered at least adequate, but with a considerable minority reporting inadequate building features or environmental conditions. The unique aspects of classroom environments magnify the effects of inadequate school building conditions, as school classrooms with 25 to 35 students have a much greater occupant density than a typical office building. Given the growing body of research strongly linking environmental conditions to student learning, improving school facilities is an important need in this country.

Green building design and operation is one viable answer to this need. The green building movement, which has been gaining considerable steam over the last decade, promotes designing and operating buildings in a way that is healthful to building occupants and the environment. When practiced in school facilities, sustainability opens the door to solving facility issues while saving on long-term operating costs and enhancing student learning.

School Buildings & the Environment – Defining Sustainability

Housing nearly 20 percent of Americans on a typical school day, school buildings have enormous potential to consume natural resources. Furthermore, recent trends in school construction reflect the nationwide phenomenon of sprawling development, with new schools most commonly being single-story structures on large sites at the edges of communities. These factors together highlight the significant effect that school buildings can have on the environment.

Sustainability is defined by the World Commission on Environment and Development as "meeting the needs of today without compromising the ability of future generations to meet their own needs." Sustainable building relies on a fully integrated, "whole building" approach to design, construction, and operation. Also referred to as *green* or *high performance* buildings, these facilities have several beneficial characteristics in common:

- Provide optimal environmental and economic performance
- Increase efficiencies, saving energy, water, and other resources
- Provide satisfying, productive, quality indoor spaces
- Are designed, constructed and operated through fully integrated processes, systems, and teams
- Educate building occupants about efficiency and conservation

Integrated design and operation hinges on a deep understanding of the interplay between building systems and features and requires collaboration between all stakeholders from the earliest stages of the project onwards. Patrick L Herron, Ed.D., Former Assistant Superintendent of Wake County Schools in Raleigh, North Carolina, offers his perspective on the benefits of an integrated sustainable design strategy: "The Durant Road Middle School project was Wake County's first experience with daylit schools, and exceeded all expectations. The project was under budget and the payback for the daylighting features were less than two years. This was due to the downsizing of the mechanical and electrical systems and the reduction in energy costs, made possible by the daylighting." Without an early understanding in the design process of how daylighting features would alter heating, cooling and lighting loads in this facility, the savings ensuing from equipment downgrades may not have been realized. This comprehensive, systemic approach to buildings is vital to sustainability, and extends beyond the design phase to the entire operational life of the building.

There are several known criteria for designing, operating and maintaining sustainable buildings that provide economic and environmental benefits and also positively impact student health and learning. Below is a compilation of some of these criteria:[3, 4, 5]

- Sustainable site planning and landscaping design that decrease the use of pesticides and provide an outdoor learning environment for students
- Good building envelope design such as efficient windows and high R-value insulation that reduce draftiness and increase student and teacher comfort levels
- Proper lighting along with increased use of daylighting to improve student performance and increase comfort levels
- Good indoor air quality from adequate air filtration and exchange systems and the banning of idling buses or delivery trucks near buildings that eliminate toxins, allergens and other harmful pollutant sources. Incorporating natural gas, biodiesel, methanol, or solar electric buses into a district's existing vehicle fleet would also reduce harmful emissions and improve air quality in and around the school.
- The use of green supplies and materials to eliminate or minimize possible sources of toxins, allergens and other harmful pollutants such as volatile organic compounds (VOCs) or formaldehyde. Use of green supplies and materials will also reduce contributions to lung ailments such as asthma.
- Proper design and maintenance of heating, cooling, and ventilation systems that run quietly and efficiently and do not produce noisy distractions to student learning. Using certain controls can minimize noise distraction. The relatively small size of a typical classroom makes this decision more critical, because the effect of ventilation air noise is greater than in a larger space such as a gymnasium.
- Onsite renewable energy sources, such as photovoltaics, that can be used as a teaching tool to develop student interest in alternative energy sources

[3] Ohio Energy Project. *Energy Smart Schools: Creating a Sustainable Learning Environment in Ohio*. 2000. Ohio's EnergySmart Schools Program Booklet.
[4] U.S. Department of Energy. *Energy-Smart Building Choices, How School Administrators and Board Members are Improving Learning and Saving Money.* U.S. DOE Office of Building Technology, State and Community Programs (BTS) Energy Smart Schools Brochure, DOE/GO-102001-1430, August 2001.
[5] Frenette, Edward, Dion, Martine, Halm, Patrick, Ferzacca, Nick and Andy Oldeman. "In Equal Measure, Addressing the broad spectrum of indoor environmental quality in school and university buildings." *American School and University*, July 2003: pp. 34-41.

Green Advantages

In addition to protecting the environment, sustainable buildings benefit schools and communities in myriad ways, from economic savings in long-term operating costs to improving teacher retention and bolstering student performance. Additional benefits include lower building insurance rates, decreased liability, improved community relations and higher safety levels for students, teachers and other building occupants.

Increased Teacher Retention

The U.S. education system, with increasing enrollment, a push for smaller class sizes, and the looming retirement of baby boomer-aged educators, is on the brink of a teacher shortage. Some analysts speculate that the cause of this shortage is not due to a lack of new teachers, but instead is a result of high rates of attrition among beginning teachers, with about 25 percent of all new teachers leaving the profession within four years.[6]

One factor in high attrition rates is the condition of school facilities. Environmental conditions can significantly affect the experience teachers have in the classroom in terms of their ability to effectively educate students, their personal health and wellbeing, and their overall satisfaction with their profession. In one teacher survey, greater than 25 percent of Chicago teachers and approximately one-third of Washington, DC teachers reported suffering health issues such as sinus infections, asthma and other respiratory problems that they attributed to poor environmental conditions in their schools.[7] In additional to causing lost teacher time, a majority of the teachers who reported experiencing adverse health effects as a result of poor school facilities were considering changing schools or leaving the profession altogether.[8]

Many factors beyond facility conditions contribute to teacher attrition, including teacher age, time in the profession, wages, and community dynamics. However, of these, improving school facilities may be one of the most viable and economically feasible strategies school districts can employ to increase teacher retention.[9] Green building practices that address IAQ, thermal conditions, daylighting, and noise control are particularly important in shaping positive teaching experiences in the classroom.

Improved Student Health and Performance

School facilities affect student health and learning. While the interrelationship between buildings, occupant health, and performance may not be perfectly understood, growing evidence and common sense dictate that children cannot learn as well in suboptimal facilities that trigger health symptoms, cause discomfort, or are distractingly noisy.[10] Indoor air quality (IAQ), daylight, thermal conditions, acoustics and other factors that collectively shape overall indoor environment quality (IEQ) play a significant role

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[6] Benner, A.D. *The cost of teacher turnover*. Austin, TX: 2000. Texas Center for Educational Research. 16 January 2006 <http://www.sbec.state.tx.us/SBECOnline/txbess/turnoverrpt.pdf>.

[7] Schneider, M. *Linking School Facility Conditions to Teacher Satisfaction and Success*. Washington, DC: 2003. National Clearinghouse for Educational Facilities. 5 January 2006 <http://www.edfacilities.org/pubs/teachersurvey.pdf>.

[8] Ibid.

[9] Buckley, J., Schneider, M., and Yi Shang. 2004. *The Effects of School Facility Quality on Teacher Retention in Urban School Districts*. Washington, DC: National Clearinghouse for Educational Facilities. 5 January 2006 <http://www.edfacilities.org/pubs/teacherretention.html>.

[10] Schneider, M. 2002. *Do School Facilities Affect Academic Outcomes?* Washington, DC: National Clearinghouse for Educational Facilities. 5 January 2006 <http://www.edfacilities.org/pubs/outcomes.pdf>.

in creating good learning spaces. Additional variables known to influence student achievement include school size, class size and design.

IAQ is a primary variable in maintaining healthy indoor environments conducive to learning. Contaminants in indoor spaces may be two to five times – and sometimes greater than 100 times – higher than outdoor levels.[11] This, along with the significant amount of time that students and teachers spend inside schools and children's increased susceptibility to pollutants, underscores the importance of good indoor air quality. Symptoms associated with poor IAQ include:

- Headache
- Fatigue
- Shortness of breath
- Sinus Congestions
- Cough
- Sneezing
- Eye, nose and throat irritation
- Skin irritation
- Dizziness
- Nausea

The above symptoms are collectively referred to as "sick building syndrome" (SBS), a term used to describe situations in which building occupants experience acute health and comfort effects that appear to be linked to time spent in a building, but no specific illness or cause can be identified. Conversely, the term "building related illness" (BRI) refers to situations when symptoms of diagnosable illness are identified (e.g., certain allergies or infections) and can be attributed directly to airborne building contaminants. Asthma attacks, allergic reactions, the spread of disease, and exposure to toxic substance are other health effects that are exacerbated by or stem from building conditions.[12, 13]

In addition to threatening students' wellbeing, the health impacts of poor indoor air affect concentration, attendance, student performance and achievement. According to the American Lung Association, asthma, which is exacerbated by poor indoor air quality, alone accounts for 14 million missed school days each year, making it a leading cause of school absenteeism. Research on asthma in schoolchildren by Smedje and Norback confirmed that asthma prevalence in schools is associated with elements of poor air quality: higher relative air humidity, higher concentrations of volatile organic compounds and mold or bacteria.[14]

Numerous daylighting studies have also established links between facility features and learning. The 1992 "Study into the Effects of Light on Children of Elementary School Age: A Case of Daylight Robbery" was conducted in Alberta, Canada by the Policy and Planning Branch of Alberta Education. Over a two-year period, the study compared children attending elementary schools with full-spectrum light versus children attending similar schools with normal lighting conditions.

The two-year study found that students under full spectrum light with trace ultraviolet:[15]

- Learned faster
- Tested higher
- Grew faster and had 2/3 fewer cavities than expected
- Had 1/3 fewer absences due to illness (3.5 fewer days absent per year)

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[11] U.S. Environmental Protection Agency. *Indoor Air Quality Backgrounder: The Basics*. 5 January 2006 <http://www.epa.gov/iaq/schools/tfs/pdf_files/backgrounder.pdf>.

[12] Collaborative for High Performance Schools Web Site. 2003. Collaborative for High Performance Schools. < http://www.chps.net/>.

[13] U.S. Environmental Protection Agency. *Indoor Air Quality & Student Performance*, EPA Report number 402-K-03-006, August 2003.

[14] Smedje G. and D. Norback. "New Ventilation Systems at Select Schools in Sweden–Effects on Asthma and Exposure." *Arch Environ Health*, 55.1 (2000):18-25.

[15] Hathaway, Hargreaves, Thompson, and Novitsky. *A Study Into the Effects of Light on Children of Elementary School Age – A Case of Daylight Robbery*. Alberta, Canada: Jan. 1992. Policy and Planning Branch, Planning and Information Services Division, Alberta Education.

These results support the conclusion that lighting systems are not neutral and have non-visual effects on people who are exposed to them over long periods of time. Prompted by the conclusions of this Alberta, Canada study, North Carolina Innovative Designs architects, Michael Nicklas and Gary Bailey, investigated the performance of students attending three daylit schools designed by their firm. They found that students in daylit schools, both new and retrofitted, performed better than the county norm in every case. More specifically, the students who attended daylit schools outperformed the students who were attending nondaylit schools by 5 to 14 percent, depending upon whether you consider short or long-term impacts. This study also found that "new" does not necessarily translate into better performance. A new, non-daylit school actually showed a negative impact on the students' performance.[16]

In 1999, the Heschong Mahone Group completed one of the largest and most rigorous studies investigating the relationship between daylighting and student performance. Results indicated that students in classrooms with the most daylighting progressed faster and scored higher on standardized tests than students with the least daylighting. A 2001 reanalysis of the data showed that overall, elementary school students in classrooms with the most daylight showed a 21 percent improvement in learning rates compared to students in classrooms with the least daylight. The study also found that students with well-designed skylights in their room, ones that diffused daylight and allowed teachers to control the amount of light entering the room, progressed 19 to 20 percent faster that those students without a skylight.[17, 18]

Sustainable building design and operation, by definition, strives to protect occupant health and wellbeing. In educational environments, the links between health and student achievement make IEQ and other building features that affect occupants all the more significant. Many of the building issues that negatively affect student health and learning can be addressed through green building practices.

Long Term Savings

Sustainable school buildings benefit school district and community bottom lines, primarily by reducing life cycle operating and maintenance costs. K-12 schools in the U.S. spend over $6 billion a year on energy. In fact, energy costs tend to be second only to salaries in school budgets, exceeding the costs of supplies and books.[19] According to the U.S. Department of Energy, investing in energy-efficient renovations—replacement of inefficient boilers, lighting, and other systems—could reduce school energy costs by 30 percent.[20] Proper maintenance of building systems also reduce life cycle costs by extending the life of equipment, avoiding more costly repairs through preventative measures, and ensuring that systems are operating as intended. This is money that could be spent on hiring new teachers and purchasing textbooks, computers and other instructional materials.

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[16] Nicklas, Michael H. and Gary B. Bailey. *Student Performance in Daylit Schools; Analysis of Performance of Students in of Daylit Schools.* Raleigh, NC. Innovative Design Report, 1996. 31 January 2006 <http://www.innovativedesign.net/pdf/studentperformance.pdf>.

[17] Heschong Mahone Group. *Daylighting in Schools: An Investigation into the Relationship Between Daylighting and Human Performance*, Detailed Report. Fair Oaks, CA: Pacific Gas and Electric Company, 1999.

[18] Heschong Mahone Group. *Daylighting in Schools*, Additional Analysis, Detailed Report. Fair Oaks, CA: New Buildings Institute, 2001.

[19] Alliance to Save Energy. 2003. *Green Schools, An Investment in our Children's Future.* Alliance to Save Energy Green Schools Program, 31 January 2006 <http://www.ase.org/section/program/greenschl/about>.

[20] U.S. Department of Energy. *High-Performance Commercial Buildings: A Technology Roadmap*. 2000. 27 January 2006 <http://www.eere.energy.gov/buildings/documents/pdfs/roadmap_lowres.pdf>.

Curricular Opportunities

Green schools promote learning not only by furnishing optimal conditions, but also by virtue of the very practices and equipment accessible to students on the site. The sustainable technologies and strategies used in high-performance schools offer a wealth of teaching opportunities that educators can incorporate into their curriculum to provide students with hands-on learning opportunities. From solar energy systems on the roof to restored wetlands in the schoolyard, green schools can be exciting laboratories used to demonstrate concepts in virtually all disciplines.

Gary Bailey, Vice President of Innovative Design, concurs, "Sustainable Schools create better learning environments. The concept of sustainable development reflects an understanding that we must meet the needs of the present without compromising the ability of future generations to meet their own needs. A Sustainable School not only embraces the concept of sustainability but is, in itself, a teaching tool for sustainability."

Curriculum Case Study, Lincoln Elementary School

A team of teachers, administrators and custodial staff from Lincoln Elementary School in Madison, WI are participating in the Green and Healthy Schools Program. This program helps schools adopt safe and environmentally sound practices, as well as develop strategies to integrate green practices into curriculum and promote community involvement. Clare Seguin, a science enrichment teacher who teaches hands-on science to every student in the school, is leading the effort.

According to Seguin, using the school building and green practices as a teaching tool offers numerous curricular opportunities, helps students develop meaningful relationships with the spaces in which they learn, and forges connections with the larger community. For example, students are using real-time energy data from their school to learn about trends in energy consumption and make correlations between behavior and consumption. When coupled with lessons about electricity sources and the environmental impacts of its generation, students come to understand the benefits of and opportunities for conserving energy. Seguin's students are now taking a proactive role in promoting energy efficiency in their school, and have initiated a poster campaign urging students and teachers to turn off lights and computer monitors when they are not in use.

The impacts of this green school initiative are extending beyond the school itself. In October 2005, students held a compact fluorescent light bulb sale and sold over 1,500 bulbs to parents, friends, and neighbors. The sale helped students to earn funds for environmental education activities and allowed them to share their knowledge about the benefits of energy efficiency with the larger community. Following the sale, students calculated the reduction in CO_2 emissions that will result from the bulbs they sold. This came to 2,860,032 lbs.– a number that impressed them greatly. The students' next step is to study the 'carbon footprint' of the school and to look for more ways to reduce or offset that footprint.

Students have also been honing their math, science, and social studies skills through auditing the transportation patterns of the school's occupants, studying waste and recycling levels, and using worm bins for composting lunch waste. "There are so many things in my students' lives that are completely out of their control," notes Seguin, but "The Green School process is one that lets them have a direct impact on their world and helps them feel empowered rather than simply overwhelmed by environmental issues."

Overcoming Barriers to Going Green

By many measures, green building is catching on. A Turner Construction green building survey conducted over the Internet by Bayer Consulting from August 12-26, 2005 revealed that more than 70 percent of executives believe that green buildings enhance student performance and teacher retention.[21] This reflects a growing understanding of the substantial and varied benefits of greening schools. Despite this, persistent barriers have prevented its widespread adoption. Misperceptions about costs, budgetary constraints, more pressing needs, a lack of community buy-in, and information and communication obstacles between school administrators and other decision makers are all potential barriers to green school projects.

A 2004 survey conducted by Building Design & Construction and Reed Research Group shows that the expectation of higher initial construction costs is the greatest impediment to acceptance of green schools, with sixty-three percent of respondents citing this as a barrier.[22] At the same time, a Turner Construction survey showed that seventy-three percent of executives who had experience with green K-12 educational facilities expected total costs over 20 years to be lower when compared to conventional facilities.[23] This reflects a lopsided assessment of building costs, with concern for initial construction costs obscuring the long-term economic picture. As noted in the Turner report by Rod Wille, Senior Vice President, Sustainable Construction, Turner Construction, "The overall message of these findings is that far more education and information are still required about the experience with Green construction. Although most executives believed that Green facilities generate a host of benefits to their occupants and also are less expensive over time, executives appeared to lack confidence that they can achieve those outcomes. Many executives don't yet recognize the proven track record that exists for sustainable construction…"

Theresa Lehman of The Boldt Company has worked on several green education construction projects, including the John J Flynn School in Eau Clair, WI, and the Luck K-12 School in Luck, WI. In her experience, misperceptions surrounding funding issues and communication barriers between decision makers and other stakeholders are major obstacles. In addition to confirming that budget controllers tend to overlook life cycle costs, she notes that the people in charge of making decisions are often unaware of alternative funding opportunities such as performance contracting, tax benefits, tax credits and grants that reduce first cost burdens. In situations where referenda are needed to approve school construction projects, a lack of understanding among voters about the long term benefits of green can also be problematic, as information about the economic, health, and student performance benefits may not be effectively communicated to voters. Lehman held an open house with the community to share information about the Luck K-12 project and discovered that people were literally shocked at the amount of money that could be saved by incorporating energy efficiency into the HVAC and lighting systems.

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[21] Turner Construction. "Turner Green Building Survey Reveals that More than 70% of Executives Believe that Green Buildings Enhance Student Performance and Ability to Retain Teachers." *Press Release*, October 26, 2005. 27 January 2006 <http://www.turnerconstruction.com/corporate/content.asp?d=4919&p=4008>.

[22] Building Design & Construction, Reed Research Group. 2004. *Green Building White Paper Research*. 5 January 2006 <http://www.cefpi.org/pdf/GreenBuildingPerceptions.pdf>.

[23] Turner Construction. "Turner Green Building Survey Reveals that More than 70% of Executives Believe that Green Buildings Enhance Student Performance and Ability to Retain Teachers." *Press Release*, October 26, 2005. 27 January 2006 <http://www.turnerconstruction.com/corporate/content.asp?d=4919&p=4008>.

Cost Premiums

Incorrect assumptions about the cost of greening buildings remains a primary obstacle, despite the emergence of numerous studies indicating the cost premiums for sustainable building are minimal if not nonexistent. Survey results show that total long-term costs are lower than perceived, yet a lack of awareness and misperception of higher construction costs are still primary hurdles to green building.[24]

An economic analysis study, *The Costs and Financial Benefits of Building Green*, concludes that sustainable design can be incorporated into a structure with little or no increase in construction costs, and that the financial benefits of green buildings are over ten times the average initial investment required to design and construct a green building. The study states that industry perception of green building costs are considerably higher than the actual cost premiums and that in practice premiums are slightly less than 2% or $3 to $5 per square foot. This is attributed mainly to increased architectural and engineering design time, modeling, and time needed to institute sustainable building practices. It was also shown in the study that higher upfront costs for high-efficiency lighting, window, and mechanical systems are outweighed by reduced life cycle costs. Energy savings alone often exceed the average increased cost associated with building green.[25]

In a second study, Matthiessen and Moris selected 45 library, laboratory, and academic classroom projects that were designed with a goal of meeting some level of the USGBC's LEED-NC certification, and compared them to 93 non-LEED buildings with similar program types.[26] Their comparison found that although the standard deviation in dollars per square foot cost for each category (LEED-seeking and non-LEED) was quite high, since there is such a wide variation in building costs, there was no significant difference in the construction costs for LEED-seeking versus non-LEED buildings in any of the categories. The data also showed that a majority of the LEED-seeking buildings had original budgets that were set without regard to sustainable design, and yet received no supplemental funds to support sustainable goals. LEED projects that received additional sustainable goal funding usually provided only for specific enhancements or requirements, such as photovoltaic systems, typically in the range of 0–3 percent of initial budget. Matthiessen and Moris concluded that many projects can achieve sustainable design within their initial budget, or with very small supplemental funding.

Even in cases were green features add to upfront costs, the return on this investment is substantial. A study released in October 2002 by the David and Lucille Packard Foundation found that with each increasing level of LEED sustainability for their Los Altos Project, short-term costs increased, but long-term costs decreased dramatically.[27] As green construction techniques and building equipment become more mainstream, the small premium for green building will only decrease. Furthermore, the healthier environments furnished by sustainable schools can bring money into the school by lowering absenteeism and increasing funding based on Average Daily Attendance.[28]

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[24] Ibid.
[25] Kats, Greg, et al. *The Costs and Financial Benefits of Building Green: A Report to California's Sustainable Building Task Force.* Sustainable Building Task Force, 2003. 27 January 2006 <http://www.usgbc.org/Docs/News/News477.pdf>.
[26] Matthiessen, L. F. and P. Moris. *Costing Green: A Comprehensive Cost Database and Budgeting Methodology.* Davis Langedon Adamson Report, 2004. 31 January 2006 <http://www.davislangdon.com/pdf/USA/2004CostingGreen.pdf>.
[27] David and Lucille Packard Foundation. *Building for Sustainability: Six Scenarios for the David and Lucille Packard Foundation Los Altos Project*. October 2002.
[28] U.S. Environmental Protection Agency. *IAQ Tools for Schools Kit - IAQ Coordinator's Guide*. Office of Radiation and Indoor Air, Indoor Environments Division (6609J), EPA 402-K-95-001 (Second Edition): 2000.

Financing Constraints

Tightening school budgets, rising energy costs, and increased standardized testing of students have increased the economic pressure on K-12 school administrators who are trying to maintain and improve their deteriorating school facilities. In the face of financial constraints, school districts often choose to defer even basic maintenance and are unlikely to invest in new equipment, regardless of the long term savings. This creates an unfortunate situation in which wise investments, in terms of long-term savings and benefits, are eschewed in favor of immediate short-term needs. Lack of capital, though, does not have to be a constraint for facility upgrade projects. Many school districts are discovering lease and lease purchase agreements as viable financing instruments for upgrading their facilities. Equipment and improvements are acquired from a private vendor such as an energy service company (ESCO) that may finance them internally or through a third party. Up-front outlays are not required from the building owner. One increasingly popular vehicle of this type for financing energy efficiency upgrades are energy savings performance contracts (ESPCs). ESPCs are an affordable way to make investments in new energy-efficient equipment. They are unique contracts through which private ESCOs provide energy-efficiency improvements to facilities at little or no up-front capital cost to the customer.

ESPCs can be structured to take advantage of any combination of financing alternatives. School districts can make the upgrades they need now and pay for them later through the resulting energy savings. Facilities owners and operators benefit immediately through new equipment, expertise from energy service professionals, ongoing maintenance services and the ability to accomplish many projects all at once. Best of all, these savings can be guaranteed. The school district retains any savings that exceed the ESPC payments during the duration of the contract, and retains all savings once the contract is complete.

After entering into an agreement with an ESCO, the ESCO will identify and evaluate energy-saving opportunities and then recommend a package of improvements to be paid for through the savings. The ESCO will guarantee the energy savings and work to structure the project so the energy bill cost savings meet or exceed the annual payments to cover all the project costs. These contracts and guarantees usually last 7 to 15 years and if the energy savings do not materialize, the ESCO is responsible for paying the difference for the energy savings shortfall. To ensure savings, the ESCO offers staff training and long-term maintenance services.[29]

Designing, Operating and Maintaining Sustainable Buildings

Integrated design is a key component of successful green building projects. Ideally, a whole-building mindset is employed from the start of the design process through the building's entire life cycle, resulting in the optimum performance of building systems and satisfaction among occupants.

Ventilation Effectiveness & Indoor Air Quality

Indoor air quality is one of the most significant factors in keeping building occupants comfortable and healthy. "In order to have a good learning environment, you must have a learning environment that's conducive to education, and that means good air quality. Children don't learn well if they're too hot, too cold or if their lack of fresh air leaves them drowsy." acknowledges Ed Melanson, Superintendent of Schools for the SAU #18 School District in Boscawen, New Hampshire. However, according to Department of Education, National Center for Education 1999 Statistics, one-half of our nation's 115,000

[29] National Association of Manufacturers. *Energy Efficiency, Water and Waste-Reduction Guidebook for Manufacturers, Proven Ways To Reduce Your Costs and Improve Operations*. NAM Report: 2005.

schools have problems linked to indoor air quality.[30] Effective air filtering and ventilation, along with pollutant source control, go a long way towards solving IAQ issues in buildings. In addition to protecting occupant health and aiding student achievement, preventing IAQ problems is less costly than resolving IAQ problems after they develop.[31] As school funding is often based on attendance, schools with good indoor air quality are also likely to receive more funding, have higher teacher retention rates, and spend less on substitute teachers to replace sick members of the staff.[32] This can improve continuity in school programs and provide students with higher quality education.

Two major sources of indoor air quality problems are heating, ventilation and air conditioning (HVAC) systems, and contaminants. The HVAC system controls the circulation of air throughout a building, the introduction of fresh air into the mix, and the filtration of airborne particles. If poorly ventilated or seldom cleaned, these systems can pump contaminants through a building again and again. One of the most common building pollutants is mold, which can significantly impact health and also contributes to building bio-deterioration and premature aging of a building's mechanical systems. Other sources of contaminants include chemical pollutants, particulates, allergens and outdoor air contaminants that make their way into the building.

Not surprisingly, strategies for maintaining good IAQ generally involve a two-pronged approach involving both HVAC systems and pollutant source control. Designing and constructing buildings with adequate HVAC systems that effectively ventilate all occupied airs and minimize the collection of dirt, moisture and microbial growth is a critical first step. Once occupied, operation and maintenance procedures of the HVAC system should be consistent with the original design specifications. Other building features and operating procedures within the building can help with pollutant source control, such as entryway systems designed to capture dirt and particles on the shoes of occupants entering the building, placing air intakes well away from areas where buses and other vehicles might be idling, or using safe cleaning chemicals and other green products instead of conventional, harsher chemicals.[33, 34]

Temperature, Humidity & Thermal Comfort

The relationship between temperature and student learning has been well-studied, with research spanning three decades pointing to a direct correlation between temperature, occupant comfort and performance.[35] Indoor temperatures, particularly temperatures higher than or at the upper levels of the generally accepted range of comfort, have been repeatedly linked to increased levels of negative health symptoms in occupants.[36] Due to varying individual preferences, it is not possible to create spaces where every

[30] U.S. Department of Education, National Center for Education Statistics. 1999. 27 January 2006 <http://nces.ed.gov/>.
[31] U.S. Environmental Protection Agency. *Indoor Air Quality Backgrounder: The Basics*. 5 January 2006 <http://www.epa.gov/iaq/schools/tfs/pdf_files/backgrounder.pdf>.
[32] State of California, Division of the State Architect. *Sustainable Schools Resource: Indoor Environmental Quality* 2003. 5 January 2006 <http://www.sustainableschools.dgs.ca.gov/SustainableSchools/sustainabledesign/ieq/iaq/iaq.html>
[33] U.S. Department of Energy. *Get Smart About Energy: Save Money. Create Better Places To Teach and Learn*, Office of Building Technology, State and Community Programs (BTS) Energy Smart Schools Program Folder (Revision) - DOE/GO-102002-1524; NREL/BR-810-31606, 2001.
[34] Collaborative for High Performance Schools Web Site. 2003. Collaborative for High Performance Schools. < http://www.chps.net/>.
[35] Schneider, M. 2002. *Do School Facilities Affect Academic Outcomes?* Washington, DC: National Clearinghouse for Educational Facilities. 5January 2006 <http://www.edfacilities.org/pubs/outcomes.pdf>.
[36] U.S. Department of Education, Office of the Under Secretary. *A Summary of Scientific Findings on Adverse effects of Indoor Environments on Students' Health, Academic Performance and Attendance*. Doc #2004-06, by M.J Mendell and G. Heath, Washington, DC, 2004.

occupant experiences optimal comfort. However, heating or cooling spaces so that temperature and humidity conditions fall within commonly acceptable ranges is vitally important for fostering student achievement, maintaining student attention, and enabling teachers to be successful and satisfied in their jobs.[37]

In addition to the direct link to comfort and performance, temperature and humidity levels influence IAQ based on their connection to the presence of mold and bacteria. High humidity levels can contribute to mold growth, which in turn can exacerbate allergic responses and incidences of SBS among occupants.[38] However, excessively low humidity levels, which minimize mold and bacteria growth, are also undesirable, with evidence showing that low humidity can contribute to absenteeism.[39]

Classroom-level controls for thermal conditions may be the best opportunity for providing optimal environmental conditions and thereby enhancing student performance, and are also seen as an important booster to teacher morale and effectiveness. In a 1990 assessment of highly-regarded teachers (recipients of State Teachers of the Year Awards), one researcher discovered that these top performers signified that their ability to control classroom temperature was of primary importance to the success of both students and teachers.[40] Because of their positive effect on occupant comfort and performance, enhanced thermal control systems are a significant element of green buildings and often lead to increased energy efficiency as well as improved environmental conditions.

Acoustics

High levels of background noise, much of it from HVAC systems, adversely affect learning environments. Research has consistently linked good acoustics to good academic performance, and this is particularly true for young children who require optimal conditions for hearing and comprehension.[41] Earthman and Lemasters reported three key findings in a 1998 report: that higher student achievement is associated with schools that have less external noise, that outside noise increases student dissatisfaction with their classrooms, and that excessive noise causes stress in students.[42] Teachers are also affected by classroom acoustics, with poor acoustics limiting their ability to provide quality instruction.

For children who have hearing loss or use cochlear implants, poor classroom acoustics present an additional educational barrier. Assistive hearing technologies, such as cochlear implants, amplify both wanted and unwanted sound.[43] According to the U.S. Architectural and Transportation Barriers Compliance Board, an independent federal agency devoted to accessibility for people with disabilities, acoustical performance is an important consideration in the design of classrooms. In 1998, the U.S. Access Board joined with the Acoustical Society of America (ASA) to support the development of a

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[37] Schneider, M. 2002. *Do School Facilities Affect Academic Outcomes?* Washington, DC: National Clearinghouse for Educational Facilities. 5 January 2006 <http://www.edfacilities.org/pubs/outcomes.pdf>.
[38] Bates, J. "Healthy Learning." *American School &University*. 68.5 (1996), pp. 27-29.
[39] Leach, K. "In sync with nature: Designing a building with improved indoor air quality could pay off with improved student health and performance." *School Planning and Management* 36.4 (1997): 32-37.
[40] Lowe, J.M. 1990. *The Interface Between Educational Facilities and Learning Climate in Three Elementary Schools*. Ph.D. diss. College Station, TX: Texas A&M University.
[41] U.S. Architectural and Transportation Barriers Compliance Board, 2002. *Progress toward a new standard on classroom acoustics for children with disabilities*. 19 January 2006 <http://www.access-board.gov/acoustic/index.htm>.
[42] Earthman, G. I., and L. Lemasters. *Where children learn: A discussion of how a facility affects learning*. Paper presented at the annual meeting of Virginia Educational Facility Planners. Blacksburg, Va., February 1998.
[43] U.S. Architectural and Transportation Barriers Compliance Board, 2002. *Progress toward a new standard on classroom acoustics for children with disabilities*. 19 January 2006 <http://www.access-board.gov/acoustic/index.htm>.

classroom acoustics standard. Stakeholders from both public and private sectors, including industry, were involved. Their work, completed in 2002, was approved as ANSI/ASA S12.60-2002, Acoustical Performance Criteria, Design Requirements and Guidelines for Schools. Consistent with long-standing recommendations for good practice in educational settings, the new standard sets maximum limits for background noise (35 decibels) and reverberation time (0.6 to 0.7 seconds) for unoccupied classrooms.[44] Although voluntary, this Standard can be adopted into existing code and rating systems.

Integrated green building design and facility upgrades can improve many of the existing acoustical problems in schools. For example, including daylighting in building design and upgrades often allows downsizing of HVAC and other mechanical and electrical systems. Smaller and newer equipment likely operate at lower noise levels, leading to improved classroom acoustics.

Lighting

Many of the classrooms built in the school construction boom following the 1950's have little daylighting. Schools windows were commonly built with "black glass" that allows a view out, but no useful daylight in, and many classrooms were designed with no windows at all. This was done to make air-conditioning more efficient, reduce external noise, lower maintenance costs and bolster security.

Since the early 1990's building trends have reflected growing acknowledgement of the substantial advantage offered by daylighting in classrooms. The availability of high-efficiency windows and skylights, along with recognition of the positive effects on student learning, is pushing the trend forward.[45] Daylighting reduces the need for electrical lighting and cooling, and cuts lifetime energy expenses. It also makes school buildings more attractive and, perhaps most importantly, improves students' health and productivity.[46] Peggy Smith, Principal of East Clayton Elementary School in Clayton, North Carolina, agrees, "I firmly believe every child deserves an environment like this - one designed to be conducive to learning. This is a vision of what all schools should be like for every child." "You just feel energized and when children are energized, they are more apt to learn, ... that's what daylighting does."

Daylighting features are easiest to incorporate into buildings during the early phases of design, although building renovations also offer opportunities for providing daylighting. Baffles, roof monitors, skylights and clerestory structures, in addition to windows, can all be used to bring natural lighting into a building. Diffusing and control devices are also important features, as they prevent glare, unwanted heat gain, and undesirable or inconsistent lighting levels.

Building Age

Making a choice between renovating older facilities and constructing new schools is a dilemma that every school district faces as building stock ages and community demographics and school enrollments shift. In many cases, misguided funding formulas, inflexible site standards and a lack of information about successful renovation strategies result in new construction even when the community, students and the environment would be better served by improving existing facilities.[47]

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[44] Ibid.
[45] Beny, J.R. 2001. *Lighting for schools.* Washington, DC: National Clearinghouse for Educational Facilities. 24 January 2006 from <http://www.edfacilities.org/pubs/lighting.html>.
[46] Schneider, M. 2002. *Do School Facilities Affect Academic Outcomes?* Washington, DC: National Clearinghouse for Educational Facilities. 5 January 2006 <http://www.edfacilities.org/pubs/outcomes.pdf>.
[47] National Trust for Historic Preservation. 2003. *Smart Growth Schools: A Fact Sheet.* Washington, D.C. 6 January 2006 <http://www.nationaltrust.org/issues/schools/schools_smartgrowth_facts.pdf>.

The relationship between school age and performance is often oversimplified. Older schools offer a number of benefits that tend to be absent in newer buildings, including smaller size that often means a better educational experience for students, large windows and other desirable architecture features, and neighborhood locales that foster community involvement and allow students to easily walk or bike to school.[48] Conversely, older schools are more likely to suffer from inadequate ventilation, subpar building systems, inflexible space uses, and poor learning conditions than newer schools. Additionally, integrating sustainability into new construction projects during the design phase is generally simpler and presents opportunities beyond what can typically be achieved in existing buildings. Despite these potential drawbacks, well-maintained and periodically updated buildings can provide an optimal learning environment regardless of when they were first constructed.

In its 2000 report on the condition of school facilities in the United States, the National Center for Education Statistics found that a school's "functional age", or the time since last renovated, is far more significant in predicting its condition than the year of original construction.[49] Nearly half of all public schools were built between 1950 and 1969, reflecting the burgeoning enrollments that came with the Baby Boom generation. But despite having an average age of 42 years in 1998, the vast majority (73 percent) of public schools report having undergone at least one major renovation.[50]

As a result of these complex tradeoffs, administrators considering building projects should be cautious about automatically assuming that new schools are the better alternative in terms of environmental, economic and student performance. This is especially true where construction standards for new schools mandate large school sizes or include huge acreage requirements, essentially guaranteeing a sprawl school that is isolated from the larger community and cannot be safely accessed via alternative transportation. Various resources for maintaining, upgrading, and operating buildings in a sustainable way, such as the LEED for Existing Buildings program, help building owners utilize new technologies and strategies to optimize the performance of the building over the long term.

School Size

The trend for school buildings over the past 50 to 75 years has been consolidation towards larger and larger schools. Today, high-school enrollments of more than 2,000 are common, with some mega schools exceeding 5,000 students. This trend started as a result of the post World War II Baby Boom, population shifts from cities to suburbs, and from an economy of scale belief that larger schools can offer greater opportunities in extracurricular activities, specialized courses, and other choices to students at a lower cost per student.[51]

Research indicates that bigger is not always better and that reducing school size can produce multiple positive effects and few negative outcomes. Smaller school sizes are particularly beneficial for students

[48] Beaumont, C.E. 2003. *Historic Neighborhood Schools Deliver 21st Century Educations*. Washington, DC: National Clearinghouse for Educational Facilities. 15 January 2006 <http://www.edfacilities.org/pubs/historic.pdf>.
[49] U.S. Department of Education, National Center for Education Statistics. *Condition of America's Public School Facilities: 1999*. NCES 2000-032, by Laurie Lewis, Kyle Snow, Elizabeth Farris, Becky Smerdon, Stephanie Cronen, and Jessica Kaplan. Bernie Greene, project officer. Washington, DC, 2000.
[50] U.S. Department of Education, National Center for Education Statistics. *Issue Brief: How Old Are America's Public Schools?* NCES 1999-048, prepared by Cassandra Rowand. Washington, DC, 1999.
[51] Schneider, M. 2002. *Do School Facilities Affect Academic Outcomes?* Washington, DC: National Clearinghouse for Educational Facilities. 5 January 2006 <http://www.edfacilities.org/pubs/outcomes.pdf>.

from socioeconomically disadvantaged groups. A key conclusion of Nathan and Febey in their 2001 study, "Smaller, Safer, Saner, Successful Schools," was that smaller schools, on average, can provide:[52]

- a safer place for students
- a more positive, challenging environment
- higher achievement
- higher graduation rates
- fewer discipline problems
- greater satisfaction for families, students, and teachers

Classroom Design

A 2005 Hill and Cohen Report described some design and planning impacts on cognitive learning and student performance. The study discussed the relationship of students to instructional media at the front of the room. At the elementary level, several issues came to bear in distorting the fundamental cognitive learning activity of identifying shapes in K-3 grade levels: height of instructional television from student, angle of incidence from student to multimedia, and the impact of screen glare from either windows or overhead lights. The impact of design upon cognitive learning potential was even more evident in some middle and high school science laboratories. Extreme viewing angle or distance from the instructional display resulted in distorted or missing information. This has a negative impact on learning. Other classroom design factors to consider include: orientation of overhead lighting fixtures to instructional media, overall room dimensions, sound travel distances, and surface textures related to sound reverberation.[53]

When classroom design issues are examined with regard to special needs students, physically impaired students, and English as a second language students, the legal implications for educational equity are substantial. No matter where a student sits, he or she must have equal educational opportunity to learn based on the elements of the physical environment and thus, any shortfalls that may occur in the student's learning process and his or her relationship to the learning environment must purely be the result of the individual talents, temperaments, motivations, and convictions of the student.

Classroom design and size are indirectly linked. Although smaller classrooms are preferred, classroom design can include flexibility so that larger classrooms can be converted to meet the tasks at hand. Since different classroom arrangements serve different purposes, it is necessary for classrooms to have some degree of flexibility.

Class Size

Though most people agree that smaller classes are generally more desirable, the extra cost needed to provide additional classrooms and teachers remains an issue, particularly given other funding constraints faced by schools. Although more research is needed to identify the longer-term effects of small classes, the bottom line is that fewer students equates to more individual teacher attention and therefore better teacher-student relationships, while also allowing teachers more time to communicate with parents and engage them in supporting their children's education.

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[52] Nathan, J., and K. Febey. 2001. *Smaller, Safer, Saner, Successful Schools*. Washington, D.C.: National Clearinghouse for Educational Facilities and Minneapolis, MN: Center for School Change, Humphrey Institute of the University of Minnesota. 19 January 2006 <http://www.edfacilities.org/pubs/saneschools.pdf>.

[53] Hill, Franklin and Sarah Cohen. *School Design Impacts upon Cognitive Learning: Defining "Equal Educational Opportunity" for the New Millennium*, Schoolfacilities.com, Orange, CA. August 30, 2005. 5 January 2006 <http://www.schoolfacilities.com/_coreModules/content/contentDisplay.aspx?contentID=1792>.

Two well regarded studies of the Project Star and SAGE programs show positive correlations between smaller classrooms and improved student performance. In the Project STAR (Student/Teacher Achievement Ratio) Tennessee study on small-class size (1985–1990), Finn and Achilles found that students in classes of fewer than 17 (and in particular minority children and those in schools in high-poverty neighborhoods) had statistically significant achievement gains in all subject areas and at every level (K–3). Teachers and students were randomly assigned to different-sized classes so that the independent effect of class size could be measured more precisely.[54] 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
- The effects were stronger for African-American students

Subsequent findings from the Wisconsin SAGE (Student Achievement Guarantee in Education) program by Smith, Molnar, and Zahorik showed similar achievement gains for all students from class-size reductions, with especially powerful effects for African Americans. Teachers reported their SAGE students had better school attendance, were more likely to complete their homework, generally read at or above grade level, developed work habits that helped them learn and generally made the classroom easier to manage. Teachers also indicated they were able to cover more academic content because of the improved learning climate. Data collected in the Wisconsin Department of Public Instruction also show that SAGE schools are doing better in the areas of student attendance and school behavior such as suspensions. Other studies of class-size reduction experiments show improved academic achievement for students in classrooms with smaller student to teacher ratios and benefits that are sustained through middle school and high school.[55]

Getting Green Guidance – Sustainable Building Programs

Like with any innovative, growing phenomenon, the barrage of new information and technologies associated with green building can at times seem overwhelming. Fortunately, building industry leaders have been working to create a common set of standards that guide designers, builders, operators and owners in greening their facilities. School administrators can now consult several sustainable building resources when planning new construction or upgrade projects.

U.S. Green Building Council (USGBC)
www.usgbc.org

The U.S. Green Building Council's (USGBC) LEED Green Building Rating System® is emerging as one of the most widely recognized sustainable building resources in the industry. LEED (Leadership in Energy and Environmental Design) Rating Systems consist of comprehensive sets of voluntarily applied standards that designers, builders, operators and building owners can use to maximize the economic and environmental performance of buildings. The initial rating system, LEED for New Construction (LEED-

[54] Finn, J. D. and C.M. Achilles. "Tennessee's Class-Size Study: Findings, Implications, Misconceptions." *Educational Evaluation and Policy Analysis*, 21 (1999), 97–109.
[55] P. Smith, J. Molnar, A., and A. Zahorik. 2003. "Class-Size Reduction, A Fresh Look at the Data." *Educational Leadership* September 2003: pp. 72-74. 19 January 2006 <http://www.asu.edu/educ/epsl/EPRU/documents/EPRU-0309-29-RW.pdf>.

NC), provides guidance for integrating green features during the design and construction phase of new buildings, while LEED for Existing Buildings (LEED-EB) offers strategies for operating and upgrading buildings in an environmentally friendly manner during their entire functional life.

Over 225 educational institutions are members of the USGBC, and six percent (by square footage) of all LEED-registered and certified projects are K-12 facilities. LEED criteria are separated into prerequisites and credits, allowing buildings to gain points towards certification for each LEED criteria met. Perhaps even more important than the prestigious recognition that LEED certification is becoming, LEED is evolving into a blueprint for achieving high levels of economic, social and environmental returns on sustainable building investments.

EnergySmart Schools
www.energysmartschools.gov

As part of the U.S. Department of Energy's (DOE's) Rebuild America program, EnergySmart Schools (ESS) strives to foster conservation in all aspects of school energy use. ESS provides information on energy efficient solutions to transportation and building operations, as well as strategies for teaching about energy, energy efficiency and renewable energy. ESS also works to remove barriers to school energy improvements and encourages businesses to provide more energy-saving products and services tailored to schools.

EnergyStar
www.energystar.gov

The U.S. Environmental Protection Agency's (EPA's) EnergyStar® program provides guidelines for superior energy management. The EnergyStar rating system allows users to measure the energy efficiency of schools and compare them to others across the United States, based on a rating scale from 1 to 100. This baseline information, along with other EnergyStar tools and resources, can then be used to set performance targets, plan energy-efficiency improvements, and track achievements.

Collaborative for High Performance Schools (CHPS)
www.chps.net

The Collaborative for High Performance Schools (CHPS) facilitates the design of high performance schools that are energy efficient, healthy, comfortable places to learn. CHPS promotes energy efficiency in California schools by directly marketing information, services and incentive programs to school districts and designers. Although CHPS focuses on California schools, their ideas and resources can be utilized in school districts across the United States.

Other Resources

Alliance to Save Energy's Green Schools Program
www.ase.org/greenschools

This program helps schools become more energy efficient by promoting behavioral changes and operational and maintenance improvements.

National Clearing House for Educational Facilities
www.edfacilities.org/

Funded by the U.S. Department of Education, this site serves as a portal for locating publications, construction data, and other resources related to educational facilities.

U.S. Department of Energy, Energy Efficiency and Renewable Energy Building Technologies Program
www.eere.energy.gov/buildings/program_areas/

This program works to improve the efficiency of buildings and the equipment, components, and systems within them. The building program demonstrates the bottom-line benefits of new technologies and building practices, and promotes their widespread use.

U.S. EPA Indoor Air Quality (IAQ) Tools for Schools Program
www.epa.gov/iaq/schools/index.html

This web-based resource contains recommendations and tools to help communities and design professionals integrate good indoor air quality practices into the design, construction, renovation, and operation and maintenance of K-12 school facilities.