# Improving Student Achievement and School Facilities in a Time of Limited Funding*

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**Abstract**

This paper will provide a plethora of data that research has provided regarding how the learning environment can improve student performance. Over a decade of research has consistently confirmed that the physical environment impacts the learning environment and student achievement. In an era of data-driven decision making, one cannot ignore evidence that is quantified and specific. Some factors require minimum investment, but provide significant return. The authors, who come to the university after extended careers in K-12 public education, have benefited from their own responses to the findings. Their experiences and the research shared in this paper will arm the reader with the data to make changes in the built environment that can produce significant improvement in teacher morale, school climate, parent and community confidence, and student outcomes.

## 1 Sumario en espanol

Este documento ofrecerá una gran cantidad de datos que la investigación ha proporcionado acerca de cómo el ambiente de aprendizaje puede mejorar el rendimiento estudiantil. Más de una década de la investigación ha confirmado que el entorno físico afecta el ambiente de aprendizaje y rendimiento de los estudiantes. En una época de la toma de decisiones basadas en datos, no se puede ignorar la evidencia de que se cuantifica y específicos. Algunos factores que requieren una inversión mínima, sino proporcionar una rentabilidad significativa. Los autores, que vienen a la universidad después de la carrera extendida en la educación pública K-12, se han beneficiado de sus propias respuestas a los hallazgos. Sus experiencias y la investigación compartida en este trabajo se armará el lector con los datos para realizar cambios en el entorno construido que pueden producir una mejoría significativa en moral de los profesores, clima escolar, los padres y la confianza de la comunidad, y resultados de los estudiantes.

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## 2 Introduction

It's January 2009, the economic outlook is formidable, school divisions are being forced to make drastic cuts in their budgets, the state of school buildings is deteriorating yet school divisions are forced to defer maintenance or new construction, and the cry for improved educational outcomes is rising. The pressure for improved student achievement as a result of the No Child Left Behind legislation and state accountability models has placed school leaders in a quandary. Do they address critical facility needs or do they focus on the staffing of school classrooms? With this set of circumstances, school divisions are seeking cost effective ways of addressing building concerns and optimizing student outcomes.

In 1998, according to the National Center for Educational Statistics (NCES, 1999), the average age of school buildings in the United States was over 42 years. At the time of construction, the buildings were projected for a useful life of 30 years (NCES, 1999). The useful life of the school facility can be extended to approximately 50 years if major renovations take place after approximately 25 years. What some school leaders do not realize is that there is a direct and quantifiable connection between the condition of the school facility and the student achievement. This paper will provide background on the state of school budgets, the state of school buildings, the student achievement accountability standards, and ten cost effective ways to affect positive student outcomes.

## 3 The State of the Economy

The economy is suffering at a level not felt since the World War II era. School budgets, reflecting this reality have been cut significantly. The impact of those cuts has varied. The estimated school infrastructure need for all of the states in the United States is estimated at approximately $254.6 billion. State by state funding needs range from Vermont's $326 million to California's $25.4 billion, with the average state need around $5.1 billion (Crampton & Thompson, 2008). In the 2008-09 school year, schools reported spending on that year's construction to renovate or replace deteriorating buildings in the Commonwealth of Virginia at $611 million (Virginia Department Of Education, 2008). The Virginia Department of Education (VDOE) indicated that the construction cost per square foot remained steady, ranging from $176 to $195 for new construction, and approximately $106 for additions and renovations. Willson (2008) contends that "even though about $50 billion is spent annually on facility acquisition and construction, many of our nation's 97,000 public elementary and secondary schools need everything from minor upgrades to major overhauls." ( p. 24)

Adam Koob, in an article in the Natchez Democrat published January 17, 2009, shared the dire straits of many states as they face trimming their budgets. He indicated Governor Schwarzenegger projected cuts of more than $2 billion for schools in California. He further reported that North Carolina schools were required

[1] http://ijelp.expressacademic.org

to return $58 million to the state coffers, and in California, some proposals indicated cuts of up to $10 billion (Koob, 2009).

## 4 The Targets of Cuts

Slashed budgets have targeted everything from personnel to maintenance. Deferred maintenance, an ongoing concern for those who consider the state of this nation's school buildings, could receive additional extensions as the fight for dollars pits classroom teaching staff against aging roofs and heating, ventilation, and air conditioning (HVAC) systems. Campbell (2008) recently reported larger class sizes and delayed maintenance on schools as possible side effects of slashed budgets.

## 5 The Impact of Building Features on Student Achievement

If buildings played no role in the educating of future generations, then ignoring their further deterioration could be tolerated provided issues of structural integrity, efficiency, and safety were addressed. However, over sixty years of research continue to support the positive relationship between building quality and student achievement. Researchers within the United States have been joined by international researchers in confirming the link between the building and achievement. Cash (1993) reported that the condition of facilities can account for as many as 11 percentile points on student accountability assessments.

The American Federation of Teacher's (AFT) publication, *Building Minds, Minding Buildings: Turning Crumbling Schools into Environments for Learning*, was commissioned in response to Section 5414 of the No Child Left Behind Act on the "health and learning impacts of environmentally unhealthy public school buildings on students and teachers." (Building Minds, 2006, p. 1). The commissioned report found "poor environments in schools, ..., adversely influence the health, performance, and attendance of students."(Building Minds, 2006, p. 1) Factors such as poor lighting, inadequate ventilation, crumbling walls, damaged ceiling tiles, and inoperative heating and air conditioning systems were reported in AFT's 2006 research results. The results also included the factors of noise, overcrowding, and air quality, recognizing their link to student learning (Building Minds, 2006).

Many researchers have categorized building factors as either cosmetic or structural. The cosmetic factors, those that can be seen, consistently are linked with improved student performance. Structural factors, including heating and air-conditioning, also are linked to student achievement. Factors that have been noted repeatedly o influence student achievement include natural lighting, paint colors and paint cycles, general cleanliness, air quality, temperature control, acoustical enhancements, safety features, absence of graffiti, and air conditioning.

Cash (1993), in a study of small rural high schools in Virginia found a connection between building condition and student achievement as measured by standardized tests. The factors that were major contributors to the identified relationship included windows in classrooms, cleanliness, absence of graffiti, and presence of air conditioning. This study was replicated in large high schools in Virginia (Hines, 1996) with similar findings. The same methodology was employed in a study of high schools in North Dakota (Earthman, Cash, & Van Berkum, 1995) and the results were consistent with those from the earlier studies. O'Sullivan (2006) found similar results in his study of student achievement in Pennsylvania high schools. Crook (2006) examined the relationship between the condition of the physical environment and number of students who passed the Virginia Standards of Learning (SOL) examinations, and found building condition to be a predictor of student success. Lanham (1999) studied the performance of elementary school students.

Each of these studies utilized the same instrument, the Commonwealth Assessment of Physical Environment (CAPE), to determine the building physical condition. While student achievement measures varied, the connection between the building's condition and the student's academic performance was similar. In each case, windows and natural lighting, air-conditioning, cleanliness, freedom from graffiti, and wall color and paint freshness were building elements that showed a positive correlation with student achievement. Other researchers have found similar connections between student learning, behavior and buildings. (Cervantes, 1999; Earthman & Lemasters, 1996).

Duran-Narucki's 2008 study of school building condition, attendance, and academic achievement in New York City, found building conditions to be a predictor of student attendance and student achievement on standardized tests. These results were reported after controlling for other possible factors, including socioeconomic status, ethnicity, and teacher quality. (Duran-Narucki, 2008) That poorer building condition negatively impacts student attendance and that coming to school is necessary to learning are both logical arguments that continue to be supported by research.

The National Summit on School Design (NSSD) reported eight recommendations for school design excellence. These included designs to support a variety of learning styles, and the creation of healthy, comfortable, and flexible learning spaces. These recommendations have several implications for changes in the learning environment (NSSD, 2005).

While the cumulative effect of the school facility's condition has been related to student outcomes, further research has been done to pinpoint several specific factors that contribute to this overall phenomenon. These specific factors include lighting, building cleanliness, health and safety, painting, and student and teacher morale.

### 5.1 Lighting

Research has indicated that controlled day lighting and appropriate artificial lighting improve the performance of students and teachers and their health (Woodside, 2008). Research by Conway, Epps, and Plympton (2000) supported the relationship between lighting and student test scores and health. They further reported that schools found increasing natural lighting in construction did not necessarily increase the cost of construction or operational costs. Heschong-Mahone Group (1999) reinforced the positive effect of day lighting in student performance.

The 2006 AFT publication points to key elements that are indicators of a commitment to high standards in schools. These include building and classroom sizes conducive to learning, adequate ventilation, heating and air-conditioning systems, extensive use of natural daylight, acoustic materials that reduce noise levels that interfere with learning, safety and security concerns effectively addressed, integrated technology, infrastructure that supports special needs students, and adequate staffing to keep schools clean and well-maintained. It further maintains that these conditions can be incorporated in new and old buildings. (Building Minds, 2006)

Both the presence of sunlight and the types of classroom lighting have been linked to improved student performance (Cash, 1993; Hines, 1996; Earthman et al, 1995; Crook, 2006). The National Summit on School Design (2005), in its recommendations, included an emphasis on daylight in learning spaces and energy-efficient and aesthetically pleasing lighting within the building. Kennedy (2008) affirmed that daylight is recognized as valuable for enhanced student performance and as a critical consideration for energy conservation.

### 5.2 Cleanliness

Several factors addressed in research relate to the cleanliness of the school facility. A connection has been made between lack of graffiti, clean floors or walls, and other measures of a school's cleanliness and student academic performance. In a survey of sophomores, according to the Educational Longitudinal Study of 2002 conducted by the National Center for Educational Statistics, disrepair and inadequate cleanliness were major concerns. Overall, in this national survey, 66% of the 10th grade students reported at least one unacceptable building condition related to vandalism, disrepair, or cleanliness. These conditions included trash on the floors, graffiti on the building, unclean floors or walls, bathroom stalls without doors, unrepaired ceilings and chipped paint on the walls (Planty & DeVoe, 2005). Further, it was noted that students who scored in the lowest quartile of their composite achievement tests were more likely than students who placed in the highest composite achievement test quartile to attend schools with trash on the floors and graffiti. (Planty & DeVoe, p. 10)

If the students found those building conditions to be unacceptable, their attitudes toward the building were impacted by the observations, and their performance may have suffered. Teacher satisfaction is also

impacted by the cleanliness and condition of the building (Ruszala, 2008). The connection between attitude, whether it is the teacher's or student's attitude, and performance is a factor that impacts student performance, teacher performance, and teacher retention.

### 5.3 Health and Safety

In the NCES longitudinal study of sophomores, the survey indicated that students were more likely to feel safe in schools with either security guards or metal detectors (Planty & Devoe, 2005). Air quality is also often associated with the health and attendance of both students and staff.

NSSD (2005) recommendations include several references to heating, ventilating, and air conditioning systems to counter those concerns. They indicated that industry trends affecting quality of the school environment included temperature distribution monitoring that can control and track temperature in all spaces in school buildings, and improved air filters for a healthier environment. They also suggested noise monitoring to maximize acoustic quality for all students.

### 5.4 Painting

Not only is the cleanliness of the school's walls important, but also the colors of those walls can impact student attitude and academic performance as well. Research supports the preference of pastel colors to dark or white walls (Cash, 1993). Further research has indicated that a focal point of one medium tone of blue, brown, or green with more neutral surrounding walls is effective in enhancing the environment of the classroom (Engelbrecht, 2003). Englebrecht also noted colors and the end-wall treatment can relieve eyestrain and stimulate the brain for learning.

Jensen (2003) indicates that for greater cognitive impact in the classroom, the best color is sky-blue tinged with red. He says "this combination is conducive to thoughtful study, but also to alertness" ( p. 17). Cafeterias and gyms, he contends, call for different colors, based on the desired student response. A recent study by Ruszala (2008) considered the relationship between teacher satisfaction and building condition. In this study, wall paint was a specific factor that emerged within the cosmetic factors as a predictor of teacher satisfaction.

### 5.5 Student and Teacher Morale

The attitudes of students and staff are important factors in student success. In recent work on how the brain works, Marzano (2007) has highlighted the relationship between students and teachers as a necessary component to student learning. Attitudes are significant in establishing and maintaining the relationships that enhance learning.

Teacher satisfaction is basic to the attitude necessary for building relationships. Ruszala's (2008) study on teacher satisfaction and building condition reaffirmed the connection between the condition of the building and the teacher's attitude.

## 6 The Countdown of Ten

As the economy continues to show signs of weakness, and recent stimulus efforts by Congress emerge without attention to school construction and school energy efficiency needs, the nation's school division leaders are struggling to find funds for physical environments. Having reminded readers of the state of the economy, the state of school buildings, and the state of research that relates buildings to student performance, this section will provide ten opportunities to invest minimally and reap rewards in student performance.

### 6.1 10 – Hire and train custodians and maintenance employees to keep the buildings structurally sound and physically attractive.

As indicated in the AFT report on buildings, one of their recommendations is the number of staff necessary to maintain and clean the building. Not only is the number of employees important, the training of those employees is essential to ensuring their effectiveness (Building minds, 2006). Cosmetic factors consistently emerge as valuable to student learning and teacher satisfaction. If students and staff report trash on the floors, graffiti on the building, unclean floors or walls, bathroom stalls without doors and chipped paint on the walls as distracters, then school leaders must address these concerns by providing staff who are trained not only to do basic cleaning but also to do minor repairs.

### 6.2 9 – Evaluate the essential repairs necessary for student and staff safety, and fix them.

Meeting the basic safety needs is fundamental to allowing a person to grow, learn, and develop. Further, repairing safety items – like covers for electric outlets – is an action that meets more than a safety need; it also sends a message of value and care that encourages students and faculty to excel. Additionally, it positions the school and school division to avoid injury to students and faculty, thus reducing the chance for litigation, another costly expense.

### 6.3 8 – Have a routine schedule for painting interior walls.

Cleanliness and attractiveness are the primary reasons to paint walls. However, the color of the walls is also important. Jensen (2003) confirms the influence of the color of surroundings on student learning by sharing the physical responses that different colors have on the brain. Determine the purpose of the room, and select the color accordingly. For example, a red wall might increase the blood pressure of students and raise their level of anxiety, while a blue or green wall might maintain a sense of calm serenity in students.

### 6.4 7 – Conduct periodic checks on ceiling tiles and repair or replace damaged or water stained ceiling tiles immediately.

Once the roof has leaked, the ceiling tile is stained. However, when the roof is repaired, the tile is still a visible sign of disrepair. Replacing the ceiling tile removes the eyesore, and the new ceiling tile serves as visible evidence that the roof has been repaired. We should not forget the health concerns related to mold. Damp ceiling tiles can be a breeding ground for mold. If replacing the ceiling tile is too expensive, another way to improve the appearance and to show signs of repair is to repaint the tiles. Some schools have used the stained tiles as an opportunity to extend learning and student expression. Math teachers have painted them as tangrams, history teachers have used them for pen and ink drawings of major characters in history, and art teachers have used them to reward students with opportunities to display their art work. The painted tiles can replace stained tiles or can be installed on the walls to improve the acoustical quality of the classroom.

### 6.5 6 - Improve the curb appeal of the school by trimming the shrubs, thus increasing visibility and enhancing safety.

When the shrubs grow too large or too low to the ground, school safety is compromised. This can provide visual protection for burglars or vandals. The unkempt shrubs also lend the impression of a facility that is not adequately maintained. Because the outside is the first impression one receives of this place of learning, its impact sets the tone for future assumptions about the quality of education served there.

### 6.6 5 –Maintain heating, ventilation, and air conditioning systems.

Clean or replace air filters as part of routine maintenance. The chiller bases and condensation areas also should be cleaned and disinfected periodically to reduce the chance of mold being circulated throughout the

building. Each of these proactive and routine maintenance activities can prolong the life of the equipment and enhance the air quality. According to Kennedy (2007), the U.S. Department of Energy's Energy Design Guidelines for High Performance Schools indicates that 41% of the energy used in a typical U.S. school is applied to cooling and an additional 14% is used for heating. Additionally, 8% is used for hot water (Kennedy, 2007). Additional savings can be reaped by improving the efficiency of heating and air conditioning systems.

### 6.7 4 – Replace chalk boards with white boards, and place them in several locations in the classroom.

By replacing blackboards and addressing the related issues of chalk dust with whiteboards, the concern about dust in electrical equipment like computers is eliminated. Concerns about air quality for students or staff members who have breathing problems is also reduced. The placement of the whiteboards in several locations supports the instructional goals of active participation by students in a more interactive environment. Window glare, which can occur when lighting enters the classroom, is less prominent with whiteboards than with blackboards, so the learning setting is improved. Another benefit of this alteration is a physical sign of building improvement or modernization.

### 6.8 3 – Improve lighting by replacing windows, uncovering windows, upgrading lighting fixtures and changing light bulbs. Use natural lighting whenever possible.

While windows may be impossible to insert in solid walls, if windows have been covered in earlier renovations, they can be uncovered. When windows are uncovered, glare can be an issue, so consider blinds as a way to control for glare. (Heschong-Mahone Group, 2003) When natural lighting is not an option, lighting within the classroom can be changed to be more reflective of sunlight in the time it takes to change a bulb.

Controlling the level of lighting in different areas of the classroom is also a valuable option (Fielding, 2006). Either being able to turn on and off banks of lights or being able to lower the intensity can allow for the change in atmosphere that allows the room to adjust for different activities.

Another simple way to reduce the cost of lighting is to install lighting controls that are motion sensitive, thus when teachers or students are out of the room the lights will switch off. As reported by Kennedy (2007), the U.S. Department of Energy's Energy Design Guidelines for High Performance Schools indicates that 30% of energy used in a typical U.S. school can be attributed to lighting. According to the U.S. Environmental Protection Agency and the U.S. Department of Energy, Energy Star qualified bulbs "use about 75 percent less energy than standard incandescent bulbs and last up to 10 times longer, save about $30 or more in electricity costs over each bulb's lifetime, produce about 75 percent less heat, so they're safer to operate and can cut energy costs associated with home cooling.

### 6.9 2 – Use wall decorations to brighten the room and to provide additional educational space and opportunities to display student work.

Jensen's (2003) research regarding teaching and the brain confirms the learning that is acquired through peripherals. Walls are attractive when posters and student work are displayed, and the learning environment is enhanced. Students learn from what is intentionally displayed on the walls in the same way they learn from lists and charts that are written on whiteboards or blackboards. Additionally, the display of student-created work as part of an enriching environment was included in Lackney's design principles and emphasized in the American Architectural Foundation's school design principles for the 21st century (NSSD, 2005).

### 6.10 1 - Bring live plants into the school facility to help with air quality and to provide a friendly school climate. Also encourage the use of music to establish a specific mood in the classroom.

This is the least expensive adjustment that you can make. Telling faculty they can have music or plants gives them permission to enhance their classroom environment. The air becomes cleaner with the addition

of plants, and the music establishes mood and counters acoustical limitations. Jensen (2003) indicated that Federal Clean Air Council studies found plants raised indoor oxygen levels and increased productivity by 10%, with a single plant increasing productivity in 100 square feet of space.

### 6.11 0 – Consider what can be added to an already scheduled replacement or renovation at little additional cost.

By bundling repair and replacement activities, there is an economy of scale that can be realized. The most effective way to explain this recommendation is to provide an example. If the air handlers require an immediate replacement which also requires access to ceiling areas, consider changing the lighting fixtures, painting the interior walls, and replacing the ceiling at the same time. This will eliminate or reduce the cost of the mobilization of the contractors or work crews. The cost of completing the additional projects will be less than the cost of doing the projects separately.

## 7 Summary

Many researchers have confirmed that student achievement is impacted by specific building characteristics and an effective learning environment. Armed with these recommendations and environmental awareness, decision makers can improve student achievement by enhancing the instructional setting, even when budgets are tight.

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