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## **Does High School Facility Quality Affect Student Achievement?: A Two-Level Hierarchical Linear Model**

Alex J. Bowers Angela Urick - *Journal of Education Finance*, Volume 37, Number 1, Summer 2011, pp. 72-94 (Article) Published by University of Illinois Press DOI: 10.1353/jef.2011.0015. For additional information about this article Access Provided by your local institution at 03/04/13 5:13AM GMT <http://muse.jhu.edu/journals/jef/summary/v037/37.1.bowers.html>

The purpose of this study is to isolate the independent effects of high school facility quality on student achievement using a large, nationally representative U.S. database of student achievement and school facility quality. Prior research on linking school facility quality to student achievement has been mixed. Studies that relate overall independently rated structural and engineering aspects of schools have been shown to not be related to achievement. However, more recent research has suggested that facility maintenance and disrepair, rather than structural issues, may be more directly related to student achievement. If there is a relationship, addressing facility disrepair from the school, district, or state level could provide a potential avenue for policymakers for school improvement. We analyzed the public school component and the facilities checklist of the ELS:2002 survey (8,110 students in 520 schools) using a two-level hierarchical linear model to estimate the independent effect of facility disrepair on student growth in mathematics during the final two years of high school controlling for multiple covariates at the student and school level. We found no evidence of a direct effect of facility disrepair on student mathematics achievement and instead propose a mediated effects model.

## **School Facility Condition and Academic Outcomes**

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In Florida, public K-12 students are being educated in two conditions, old and new school buildings, those erected prior to the statewide implementation of the State Uniform Building Code for Public Educational Facilities Construction (UBC) in 2000 and those constructed after. One research question guided this inquiry. Does the aggregate percentage of fourth, eighth, ninth, and tenth grade students passing the Florida Comprehensive Assessment Test (FCAT) mathematics and reading subtests increase after transitioning from an old school building to a new facility? A causal-comparative research design was used to determine if the academic achievement of students as measured by the mathematics and reading subtests of the FCAT increased after relocating from an old school building to a new 2000 UBC compliant facility. Two preexisting groups were used. The control group was two cohorts of students attending school in old buildings. The experimental group was two cohorts of students attending school in new buildings. The treatment was the transition from an old school building to a new 2000 UBC compliant structure. Results from this study indicated that the mean percent of students passing the FCAT mathematics subtest increased from M = 48.11 in the old school buildings to M = 54.67 in the new school buildings. The mean percent of students passing the FCAT reading subtest increased from M = 41.25 in the old school buildings to M = 44.28 in the new school buildings. The evidence from this study suggests that the quality of the school environment is important to student academic achievement.

## **WHERE SUSTAINABLE SCHOOL MEETS THE 'THIRD TEACHER': PRIMARY SCHOOL CASE STUDY FROM BARCELONA, SPAIN**

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Participatory evaluation of aspiring sustainable schools and their pedagogical potential has recently come into focus. A few authors have made a significant start in examining schools as both environmentally and socially sustainable environments, which might simultaneously represent the 'third teacher'. However, discussion around this idea is new in Spain. This paper describes a participatory post-occupancy study conducted with teachers and pupils in Fort Pienc School, Barcelona, Spain. Findings reveal the pedagogical potential of the school's spaces and fabric, characterised as 'sustainable', and highlight the aspects that the research participants feel are performing and underperforming. The paper concludes that if we want sustainable schools to be a strategy for renovating the educational process and for leading us towards a better tomorrow globally and locally, new

models for exploring the pedagogical potential of sustainable schools should be developed and the efforts of all relevant parties synchronised; from architects to governments, from pupils to teachers.

## Summary report of the HEAD Project Clever Classrooms (Holistic Evidence and Design)

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Based on the results of the HEAD Project (Holistic Evidence and Design), funded by the Engineering and Physical Sciences Research Council, clear evidence has been found that well-designed primary schools boost children's academic performance in reading, writing and maths. Differences in the physical characteristics of classrooms explain 16% of the variation in learning progress over a year for the 3,766 pupils included in the study. Or to make this more tangible, it is estimated that the impact of moving an 'average' child from the least effective to the most effective space would be around 1.3 sub-levels, a big impact when pupils typically make 2 sub-levels progress a year.

## Importance of High School Conditions for College Access

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PATHWAYS to Postsecondary Success is a series of mixed methods studies of the educational pathways of California's lower income youth. Through a series of research briefs and reports, the project aims to advance research on poverty, produce useful tools that improve educational practice, and inform the U.S. policy agenda on the relationship between poverty and education.

Importance of High School Conditions for College Access explores critical factors in preparing students for college. In this brief, Oseguera builds on a widely-used framework to set the stage for an empirical analysis of how school culture interacts with individual experiences to form students' postsecondary pathways.

Students from low-income backgrounds are less likely than their peers to enroll in and complete college, thus limiting their employment prospects in a job market that demands increasingly higher skill levels. Often, reform efforts designed to address this problem focus on individual factors such as academic performance or parental education level. But an over-emphasis on student characteristics at the expense of attention to school culture and climate undermines a more complete understanding of student achievement. By exploring high school institutional factors—including academic curriculum, teacher qualifications, and school commitment to college access—we can explain the variation in the postsecondary pathways of students from low-income backgrounds more fully than if we focus only on family or "cultural" factors.<sup>2</sup> If we overlook what is going on within schools, we may limit the potential impact of current policy initiatives on the academic success of low-income students. A focus on strengthening schools is a more proactive approach to ensuring student success.

Earlier findings on the four-year trajectories of a national cohort of tenth graders illustrate profound differences in the pathways of students from low- and higher-income families and the central role of their high school experiences in preparing them for a range of postsecondary options.<sup>3</sup> In previous analyses, only 14% of students raised in poverty completed a college preparatory curriculum when they were in high school, while close to a third (32%) of students whose families were not in poverty did so. A majority (57%) of lower-income students who finished high school without completing this type of curriculum pursued postsecondary education at the two-year level; just 34% enrolled in four-year institutions. In contrast, lower-income students who had completed an academic concentrator curriculum were more likely to enroll in four-year schools (75%) than in two-year colleges (23%). Higher income students, on the other hand, largely entered four-year colleges and universities, whether they had (84%) or had not (49%) completed an academic concentrator curriculum. This previously published research is a stark reminder of the importance of school conditions in determining the obstacles that students face as they prepare for post-high school education and a range of career options. This research brief builds on the earlier descriptive analyses to inform future empirical work on the specific school conditions that correlate with high levels.

## Can the physical environment have an impact on the learning environment?

*ISSN 2072-7925 Can the physical environment have an impact on the learning environment? CELE Exchange 2010/13 © OECD 2010  
By Peter C. Lippman, JCJ Architecture, New York*

This paper argues in favour of challenging "best practice" generally accepted by the architectural profession by embracing a responsive design approach for creating learning environments. This approach should focus on the role of the social environment and how the physical environment may be structured to support learning.

Introduction: A responsive design approach would help designers create more innovative and sustainable learning environments. Such an approach accepts that the environment shapes the learner, and that learners influence their environment. A reasonable criticism of so-called innovative learning environments is that they are neither original nor new, and generally sustainable learning environments focus on "green building" technologies and ignore other aspects of sustainability such as social development. A responsive design approach would embrace the educational ideology, practice theory, which describes the interaction between learner and environment, and link this to the concept of responsive commissioning, a research approach that explores

the nature of the interaction between the social and physical aspects of the learning environment. The designer can then create an environment that is more responsive to the needs of 21st century education.

## **Study on the Effects of Educational Environment (Physical Space and Educational Tools) on Learning and Teaching Mathematics**

*Reihane Nazari\* Department of Mathematics, Science and Research Branch, Islamic Azad University, Tehran, Iran Volume 2014, Year 2014 Article ID metr-00031, 11 Pages doi:10.5899/2014/metr-00031 Research Article*

In the survey of educational problem regarding to increasing the interested students to education, evidences show that teaching aids effect to student learning. Psychological findings show that students learn the lesson better and easier by visual method and use of teaching aids. Generally teaching aids make students senses active and also cause educational process real, practical and more pleasant. To investigate the effect of teaching aids & learning environment on mathematical achievement Lesson, 120 second grade students at Shahre Kords schools were chosen randomly and divided in control and experiment groups. Experiment groups learned mathematics by teaching aids. Training control group had normal manner. In opinion of students teaching aids & learning environment had positive effect to mathematics learning. The results of hypothesis' test show that components of educational environment (lighting system, sound, painting, etc.) have a significant role in learning mathematics ( $P < 0.05$ ). Learning environment components (lighting system, sound, painting, etc.) has effected to students performance in mathematics learning.

## **Understanding the Relationship between Student Achievement and the Quality of Educational Facilities: Evidence from Wyoming**

*Lawrence O. Picus Rossier School of Education University of Southern California, Scott F. Marion The National Center for the Improvement of Educational Assessment, Inc. Dover, New Hampshire, Naomi Calvo Kennedy School of Government Harvard University, William J. Glenn Rossier School of Education University of Southern California. PEABODY JOURNAL OF EDUCATION, 80(3), 71–95 Copyright © 2005, Lawrence Erlbaum Associates, Inc.*

A growing issue in school finance adequacy relates to the condition of school facilities and the role that the condition of those facilities plays in student learning. Using the results of standardized test scores from Wyoming students and a detailed assessment of every school building in the state of Wyoming, it can be concluded that there is essentially no relationship between the quality of school facilities and student performance when other factors known to impact student performance are accounted for. This does not suggest investments in school facilities are not important—all children are entitled to attend school in safe, clean, and appropriate educational environments. However, policy makers should be aware that investments in facilities by themselves are unlikely to improve student learning.

## **A holistic, multi-level analysis identifying the impact of classroom design on pupils' learning**

*Peter Barrett, Yufan Zhang, Joanne Moffat, Khairy Kobbacy School of the Built Environment, Maxwell Building, University of Salford, Salford M54WT, UK – journal home page: www.elsevier.com/locate/buildenv 2012 Elsevier Ltd. All rights reserved.*

The aim of this study was to explore if there is any evidence for demonstrable impacts of design on the learning rates of pupils in primary schools. Hypotheses as to positive impacts on learning were developed or 10 design parameters within a neuroscience framework of three design principles. These were tested using data collected on 751 pupils from 34 varied classrooms in seven different schools in the UK. The multi-level model developed explained 51% of the variability in the learning improvements of the pupils, over the course of a year. However, within this a high level of explanation (73%) was identified at the “class” level, linked entirely to six built environment design parameters, namely: colour, choice, connection, complexity, flexibility, and light.

The model was used to predict the impact of the six design parameters on pupil's learning progression. Comparing the “worst” and “best” classrooms in the sample, these factors alone were found to have an impact that equates to the typical progress of a pupil over one year. It was also possible to estimate the proportionate impact of these built environment factors on learning progression, in the context of all influences together. This scaled at a 25% contribution on average.

This clear evidence of the significant impact of the built environment on pupils' learning progression highlights the importance of this aspect for policy makers, designers and users. The wide range of factors involved in this holistic approach still leaves a significant design challenge.

## **The Relationship between School Building Conditions and Student Achievement at the Middle School Level in the Commonwealth of Virginia**

*Calvin C. Bullock - Dissertation submitted to the faculty of the Virginia Polytechnic Institute and State University in partial fulfillment of the requirements for the degree of Doctor of Education In Educational Leadership and Policy Studies. August 8, 2007 Blacksburg, Virginia*

The purpose of this study was to investigate the relationship between school building condition and student achievement as measured by their performance on the Standards of Learning (SOL) examinations at the middle school level in the Commonwealth of Virginia.

Three major data components were used to complete this study. The first component was the condition of the school buildings. To obtain this information, principals were asked to complete the Commonwealth Assessment of

Physical Environment (CAPE) assessment instrument. The second component was the percentage of passing scores from SOL examinations for each middle school in the Commonwealth of Virginia. The third component was the socioeconomic status of the students attending the schools as measured by the percentage of students participating in the free and reduced lunch program.

Three research questions were used to examine this topic. The first research question examined the differences in the SOL results of students in school buildings rated as standard and substandard. The second research question examined the differences in the SOL results of students in school buildings rated cosmetically as standard and substandard. The third research question examined the differences in the SOL results of students in school buildings rated structurally as standard and substandard.

This study found that building condition is related to student achievement. Students performed better in newer or recently renovated buildings than they did in older buildings. The percentage of students passing the Commonwealth of Virginia Standards of Learning Examination at the middle school level was higher in English, mathematics and science in standard buildings than it was in substandard buildings. One of the largest differences in percentage of students passing was in English at 6.10 percentage points. This difference was significant at the .05 level of significance. This is noteworthy because student's ability to read affects all other academic areas. Building age, windows in the instructional area, and overall building condition were positively related to student achievement.

Finally the data from this study were compared to the results of earlier studies that examined high schools in the Commonwealth of Virginia, finding that these results were consistent with the findings of other studies.

### **Rethinking Learning Environments to Counter Stress and Anxiety**

*Brittany E.J. de Beer. A research paper submitted in conformity with the requirements for the degree of Master of Teaching Department of Curriculum, Teaching and Learning Ontario Institute for Studies in Education of the University of Toronto Copyright by Brittany E.J. de Beer, April 2015*

Childhood stress and anxiety are becoming more and more prevalent in educational settings. Many youth today experience anxiety, stress, depression and other mental health disorders that negatively impact their social, emotional and academic achievements. With youth mental health issues on the rise, educators must work toward building positive, nurturing learning environments to counter these negative impacts on student development. This qualitative, narrative study explores the classroom experiences of two York Region elementary teachers and their observations about the implications of student stress and anxiety in a learning setting. The research and data also answer important questions regarding what exactly a positive classroom environment is and how to effectively implement such a space in one's own classroom. Key factors explored in this study include: the social/emotional environment, the physical design and organization of space, and specific pedagogical approaches that alleviate classroom anxiety and build community.

### **THE IMPACT OF SCHOOL FACILITIES ON THE LEARNING ENVIRONMENT**

*Bert Vandiver Barry Persky, PhD, Faculty Mentor and Chair Douglas DeWitt, PhD, Committee Member Joshua Fischer, PhD, Committee Member Barbara Butts Williams, EdD, Dean, School of Education. A Dissertation Presented in Partial Fulfillment Of the Requirements for the Degree Doctor of Philosophy Capella University January 2011. UMI Number: 3439537. Copyright 2011 by ProQuest LLC. All rights reserved. This edition of the work is protected against unauthorized copying under Title 17, United States Code.*

The purpose of this mixed methods study was to examine the impact of the quality of facilities on the educational environment in high schools located in northeast Texas. The intent of this research study was to determine the relationship between school facilities and the school-learning environment. This study was a mixed method research that used questionnaires and interviews to identify and appraise school facilities and learning environment. The problem was that school facilities were negatively impacting student learning and faculty, and administrators were not properly supporting stronger facility management. The poor condition of some schools raised serious concerns about teacher and student safety. Educators must understand and find ways to help increase student performance. This study used descriptive statistics to analyze the data. The independent z-test was conducted to determine the difference in student performance before vs. after the new facility. The results of the data analysis findings indicated that quality and educational adequacy of educational facilities were statistically significantly associated with student performance and teacher turnover rate showing a statistical change also

### **THE IMPACT OF SCHOOL BUILDINGS ON LEARNING**

*Research Services, Office of Assessment, Research, and Data Analysis 1450 NE Second Avenue, Suite 208, Miami, Florida 3132 (305) 995-7503 Fax (305) 995-7521. Christie Blazer, Supervisor Vol. 1204 August 2012*

This Information Capsule examines the impact of deteriorating school buildings on students and teachers. Research indicates that students attending schools that are in poor physical condition score lower on achievement tests than students in newer, functional buildings. Studies suggest that several specific factors contribute to lower levels of student performance, including poor air quality, excessive temperatures, poor lighting, and high levels of noise. Deteriorating schools have also been found to have a negative impact on student and teacher morale and have been linked to higher levels of teacher turnover.

Many educators maintain that the debate over how to improve education in the U.S. has ignored one critical element: the physical condition of schools. Students and teachers are held accountable for their performance, but it is extremely difficult to raise levels of academic achievement when teaching and learning take place in crumbling, antiquated facilities (Yeoman, 2012; American Federation of Teachers, 2006).

Millions of students attend structurally deteriorating schools that put their health and safety at risk on a daily basis. According to the Government Accountability Office and the American Society of Civil Engineers (as cited in Filardo et al., 2011), school districts have been underspending on maintenance and repair for many years.

Substandard school buildings frequently have unsafe drinking water, moldy environments, inadequate fire alarms and fire safety, inadequate ventilation, insufficient lighting, noisy classrooms, no wiring for technology, peeling paint, and crumbling plaster (Yeoman, 2012; Filardo et al., 2011; Earthman, 2004; U.S. Department of Education, 2000). The American Federation of Teachers (2006) surveyed nearly 1,000 teachers and school staff across the U.S. and reported school building problems that included “rodent infestation, mice droppings, fallen ceiling tiles, poor lighting, mold that has caused mushrooms to grow, crumbling exterior walls, asbestos, severely overcrowded classrooms and hallways, freezing rooms in the winter and extreme heat in the summer, old carpeting, clogged bathroom toilets and no stall doors, inadequate circuit breakers causing frequent outages, and poor ventilation.”

Studies have concluded that low-income and minority children are more likely to attend schools that are in poor physical condition (American Federation of Teachers, 2006; Earthman, 2004; Schneider, 2002). The 21st Century School Fund reported that from 1995 to 2004, the country’s most disadvantaged students received about half of the funding for their school buildings (\$4,800 per student) as their more affluent peers (\$9,361 per student). In addition, districts with predominantly white students had significantly higher spending on their school facilities than districts with predominantly minority students. Spending on school construction from 1995 to 2004 ranged from an average of \$5,172 per student in districts with the highest concentration of minority students to \$7,102 per student in districts with the highest concentration of white students (Filardo et al., 2006).

The age of a school building is a strong predictor of building condition. Older buildings are less likely to have features such as controlled temperatures, acceptable lighting, good acoustics, and wiring for technology that are necessary for a quality learning environment (Earthman, 2004). Schneider (2002) pointed out, however, that the age of the school building itself should not be used as a measure of its quality. He noted that some schools built in the 1920s and 1930s still provide, with some modernization, excellent learning environments, while many schools built in the cost-conscious 1960s and 1970s do not.

## **School Facility Conditions and Student Academic Achievement**

*Author: Earthman, Glen I., Virginia Polytechnic Institute and State University Publication Date: 10-01-2002 Series: Williams Watch Series: Investigating the Claims of Williams v. State of California Publication Info: Williams Watch Series: Investigating the Claims of Williams v. State of California, UCLA's Institute for Democracy, Education, and Access, UC Los Angeles Permalink: <http://escholarship.org/uc/item/5sw56439> Keywords: Williams v. State of California*

This paper shows that the condition of school facilities has an important impact on student performance and teacher effectiveness. In particular, research demonstrates that comfortable classroom temperature and noise level are very important to efficient student performance. The age of school buildings is a useful proxy in this regard, since older facilities often have problems with thermal environment and noise level. A number of studies have measured overall building condition and its connection to student performance; these have consistently shown that students attending schools in better condition outperform students in substandard buildings by several percentage points. School building conditions also influence teacher effectiveness. Teachers report that physical improvements greatly enhance the teaching environment. Finally, school overcrowding also makes it harder for students to learn; this effect is greater for students from families of low socioeconomic status. Analyses show that class size reduction leads to higher student achievement.

## **A STUDY OF THE RELATIONSHIP BETWEEN SCHOOL BUILDING CONDITIONS AND ACADEMIC ACHIEVEMENT OF TWELFTH GRADE STUDENTS IN KUWAITI PUBLIC HIGH SCHOOLS**

*Mutlaq M. Al-Enezi - Dissertation submitted to the faculty of the Virginia Polytechnic Institute and State University in partial fulfillment of the requirements for the degree of DOCTOR OF PHILOSOPHY in Educational Leadership and Policy Studies. Copy Right © Mutlaq M. Al-Enezi*

This study explored the relationship between school building conditions and the academic achievement of twelfth students in selected public high schools in Kuwait. The population of the study was 56 high schools (28 boys' schools and 28 girls' schools) that offered a Sciences and Arts majors. The major research questions in this study were: (a) is there a relationship between overall, cosmetic, and structural conditions and student achievement; (b) does the relationship between building condition and student achievement differ between boys' and the girls' schools; and (c) what aspects of physical building components are related to student achievement. The high school principals were given the revised Commonwealth Assessment of Physical Environment (CAPE) to assess building conditions. Student achievement was measured by final examination scores collected from the Information Center at the Ministry of Education.

Pearson  $r$ , was used to determine if there is a relationship between building conditions and student achievement. This analysis revealed that a positive significant relationship exists between student achievement scores and building conditions in the boys' schools. The results of two-way ANOVA and the t-test, used sequentially to compare academic achievement in the top and bottom quartiles, found that building conditions affect significantly the achievement of students in the Sciences major. The t-test highlighted significant differences in subjects in the Sciences major among only the boys' schools.

Multiple regression, used to explain the variance in student achievement, indicated that building conditions explain at least 77% of the variance of Sciences majors' achievement, but did not account for any Arts majors' achievement. Because the SES index was neither available nor introduced into a formula, this resulted in a heavier weighting given to the remaining variables. The building conditions of the girls' schools did not explain student achievement in either the Sciences or the Arts majors. Step-wise multiple regression, used to determine which physical aspects of a building's condition best predict student achievement, indicated that graffiti and roof leaks are the main predictors of achievement.

Six conclusions were drawn from this study: (a) a significant positive relationship was found between the overall, structural, and cosmetic building condition and student achievement in the Sciences major when all 56 school buildings were analyzed; (b) a significant positive relationship was found between the overall and structural building condition and student achievement in the Arts major when all 56 school buildings were analyzed; (c) a significant relationship was found between building conditions and academic achievement in boy's schools in the Sciences major; (d) building conditions had a lesser impact on academic achievement in the boys' schools in the Arts major; (e) in the girls' schools, building conditions did not affect academic achievement in either the Sciences major or Arts major; and (f) graffiti and roof leaks were the main predictors of physical aspects of a building's condition that accounted for student achievement.

This study then underscores the need for the Kuwaiti Ministry of Education to establish policy supporting a program of improved facilities for all new schools. More research is needed to extend the breath of findings regarding the relationship between building conditions and student academic achievement. This study should be replicated in other non-U.S. countries

## **AN ASSESSMENT OF THE QUALITY AND EDUCATIONAL ADEQUACY OF EDUCATIONAL FACILITIES AND THEIR PERCEIVED IMPACT ON THE LEARNING ENVIRONMENT AS REPORTED BY MIDDLE SCHOOL ADMINISTRATORS AND TEACHERS IN THE HUMBLE INDEPENDENT SCHOOL DISTRICT, HUMBLE, TEXAS**

*A Record of Study by DOUGLAS MATTHEW MONK - Submitted to the Office of Graduate Studies of Texas A&M University in partial fulfillment of the requirements for the degree of DOCTOR OF EDUCATION. December 2006*

This quantitative study investigates the adequacy and quality of middle school facilities in Humble ISD middle schools as reported by the primary users of these facilities, the teachers and administrators. These middle school educators also provide an assessment of the impact that these facilities have on the learning environment. This study also assesses the quality and adequacy of these middle school facilities through a purely quantitative evaluation conducted by an unbiased assessment team. Humble ISD is undergoing unprecedented growth at all levels and has addressed the burgeoning elementary and high school aged growth occurring in the district by constructing and renovating these facilities. At the middle level, however, new facility construction is occurring at a slower pace. The purpose of this research is to ascertain which factors in each of these six facilities have the greatest quality and adequacy and the impact that they have on the

earning environment. Furthermore, it is the purpose of this research to provide valuable and practical data, to which Humble ISD and others can refer in developing future building plans, renovating existing facilities, allocating funds, and creating student centered learning environments. This study also investigates the relationship between what educators perceive as adequate and quality facility factors and their perception of the impact that these factors have on the learning environment. Finally, this study reviews any congruency or agreement between educator's perception of adequacy and quality and architect assessment of adequacy and quality. Middle level students are the most influential group of adolescents and it is important that we provide facilities that meet their very specific needs. This research will ultimately and positively impact the learning environment for these children.

### **The Facilities Gap, Cameras in Hand, Students Capture Photos of Schoolhouse Decay**

*This article is adapted from "Building Minds, Minding Buildings: Turning crumbling schools into environments for learning," a new report from the AFT. AMERICAN FEDERATION OF TEACHERS 43 – spring 2007*

Nearly 20 years ago the American Federation of Teachers called for a "Marshall Plan" for urban schools, pointing out that the infrastructure of cities had deteriorated as federal funds were sharply reduced. Existing school buildings were crumbling and new schools were not being built. This problem has now spread far beyond the boundaries of urban school districts and touches nearly every school system in our nation. Staff in the most neglected schools struggle to educate students in conditions that few corporations—much less building inspectors—would tolerate. Mold, leaking ceilings, extreme temperatures, raw sewage seeping into hallways, mice droppings, severely overcrowded classrooms—these unhealthy and unsafe conditions plague tens of thousands of old and new school buildings where millions of American children and adults must study and work. As a Boston math teacher put it, these deplorable conditions "convey a message to the students: You are not worth the effort of providing and maintaining a good school." Unhealthy and unsafe school conditions make it difficult for students to concentrate, for teachers to teach, and for staff to do their jobs. An elementary media specialist in Lake County, Fla., put it very well when she said, "Think of how much learning could take place if heads were clear, noses were not running, and coughing were not a constant distraction."

### **The Relationship of School Facilities Conditions To Selected Student Academic Outcomes: A Study Of South Carolina Public Schools**

*Prepared For: Education Oversight Committee. Submitted By: Kenneth R. Stevenson Department of Educational Leadership and Policies College of Education University of South Carolina. Research Assistants: Sarah Main Julie Koon - 2001*

This research project sought to determine if a relationship exists between school academic outcomes and school facilities characteristics. To address this issue, data were gathered from a variety of sources including research literature, state data files, principal questionnaires, and focus groups. The major findings of the study include:

The better a principal rates the physical condition and adequacy of his or her school, the greater the likelihood that students score well on standardized achievement tests, though the socio-economic make up of the student body as measured by the portion of pupils on free or reduced lunch is heavily intertwined with this finding.

- The newer a school, the greater the likelihood that students score well on standardized achievement tests, though the socio-economic make up of the student body as measured by the portion of pupils on free or reduced lunch is heavily intertwined with this finding.
- The larger a school, the greater the likelihood that students score well on standardized achievement tests, though the socio-economic make up of the student body as measured by the portion of pupils on free or reduced lunch is heavily intertwined with this finding.
- The higher the teacher and student attendance rate, and especially student attendance, the greater the likelihood that students score well on standardized achievement tests, though the socio-economic make up of the student body as measured by the portion of pupils on free or reduced lunch is heavily intertwined with this finding.
- Most principals believe that the condition and adequacy of a school facility has a significant impact on school academic outcomes. They view the relationship as very complex, indicating that facilities affect teacher attitudes, which in turn affect classroom productivity.
- One out of every five schools in this state is rated by the principal as having a direct negative impact on school productivity.
- Among facilities factors adversely affecting the educational process are overcrowding, poor physical condition of the structure, portables, lack of storage, inadequate laboratory space.
- Because a) this study affirms previous research indicating that school facilities affect student outcomes, b) one of every five schools in this state is rated as making a negative impact on the educational process, and c) the

average school facility is 70% through its expected life cycle, it is recommended that a comprehensive and adequate system of funding school construction in South Carolina be developed and implemented.

## **A LOOK AT THE EVIDENCE LINKING SCHOOL DESIGN TO STUDENT OUTCOMES**

*By Tina Mesiti-Céas, Design Principal, Premier Diamond Partner CSArch. For more information, please contact Tina Mesiti-Céas, design principal, CSArch, at [tmesiticeas@csarchpc.com](mailto:tmesiticeas@csarchpc.com) or (518) 463.8068.*

Can renovations or new construction really improve student health and achievement? Do the outcomes actually justify the taxpayer expense? These recurring questions, often posed by school board members and community residents, can stir debate and obstruct consensus. For those in support of devoting significant funds to renovations or new construction, a response backed by strong evidence is especially crucial. The McGraw-Hill Research Foundation published, *The Impact of School Buildings on Student Health and Performance: A Call for Research*, to strengthen the understanding of the connection between school buildings and student health and learning. This paper uniquely classifies the latest research by how we see, breathe, feel, hear, move, think and learn. As defined by Dr. Lorraine Maxwell, an associate professor at Cornell University and an expert on the topic of school facilities and achievement, there are a set of psychological processes that are impacted by building design, including cognition, attention, motivation, and emotional affect. Supported by Maxwell's research in addition to that of many other field experts, when the physical state of a school building compromises how students see, breathe, feel, hear, move, think and learn, a student's cognition, attention, motivation, and emotional affect can suffer. Furthermore, teacher performance and retention, community engagement, and school leadership declines. By categorizing relevant statistics and inferences by each of the six types of experiences, the link between school buildings and student outcomes is strengthened, serving as evidence in favor of pursuing school building renovations or new construction.

## **Do School Facilities Really Impact a Child's Education?**

*Issue Tracker: John B. Lyons Date Filed: Date Filed: Date Filed: Date Filed: Date Filed: November 2001. A CEFPI Brief on Educational Facility Issues*

Learning is a complex activity that supremely tests students' motivation and physical condition. Teaching resources, teachers' skill, and curriculum — these all play a vital role in a child's education. But what about the physical condition and design of the actual school facility itself? How do they shape a child's learning experience?

Today's busy parents may never know. With most of them working, parents generally find little time to experience, much less evaluate, the physical condition of their child's school. When they do visit, often during parent teacher's night, discussions will mostly focus on their child's learning, achievement, and progress, not on school maintenance or design issues. There are few opportunities for parents to observe a classroom or school during the school day. But it is just during this time that a significant number of students and teachers struggle with such things as noise, glare, mildew, lack of fresh air, and hot or cold temperatures. About 40 percent of our schools report unsatisfactory environmental conditions.

News about these environmental nuisances is beginning to appear more and more in the media. And research is uncovering growing evidence showing that conditions like these and many other aspects of school facilities have a huge and often negative impact on children's education.

Aside from superficial conditions like mold and mildew, that exist in schools often because of poor maintenance, other problems are much more systemic. One is age. The average school today at 42 years old, faces demands that were never intended or even conceived when the building was built. Another factor is that education today is delivered in an entirely new manner, with new tools, techniques, and teaching methods that increasingly don't fit the simplistic conventions of 42-year-old school designs.

There are about 91,000 public schools today, down from 262,000 in 1930. Student population, meanwhile, has grown from 25 million in 1950 to more than 47 million today. More than 75 percent of our schools were built before 1970 — three decades ago. By age 40, most buildings start deteriorating rapidly, even if all original equipment is replaced. Typical market forces suggest retiring our 42-year-old schools. But their service continues, perpetuating crowded classrooms, outmoded designs, poor communications systems, limited technology, and inadequate security.

Many older schools can't meet Americans with Disabilities Act accessibility requirements without extensive and often expensive renovation. Moreover, their static, inflexible design can preclude the use of advanced teaching processes such as peer-to-peer and group participation. These highly interactive group learning experiences, which have overshadowed the decades-old lecture/listen style of learning, are mandated in the evolved, technologically-driven working environment that students are preparing for. The core of this teaching approach requires school designs that

have open, flexible floor plans; modular furniture; and highly mobile learning tools such as electronic chalkboards, portable computers, expandable networking, and interactive video. Few 42-year-old schools' designs can fill these needs. And the difference to a child between receiving an education in a really well-designed, modern new school and a typical 42-year-old school can be compared to the difference between writing in the sand and surfing the Internet.

Problems with older schools have been met by a flurry of critical reports and an infusion of funding. Figures on capital outlay for school construction from the National Center for Education Statistics show a 66 percent increase between 1994 and 1999. The Federal Government has initiated a one-year state grant program for emergency repairs and renovation to the neediest school districts. But momentum is against finding a simple, fast solution.

### **Building Better Outcomes: The Impact of School Infrastructure on Student Outcomes and Behaviour**

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This Digest reviews a range of research studies which examine the possible causal linkages between building design and student outcomes. It sets out those findings that are agreed and those areas where research to date is relatively inconclusive. Considerable rigorous and academically sound empirical quantitative research work has been carried out in the United States. However, the sample sizes vary between studies as do the levels of correlation between achievement and building conditions which suggests that more studies need to be carried out in this field to fully validate the findings. Conversely, in Europe, the findings appear to be based more on qualitative studies derived from social science methodology. In these cases direct causality is more difficult to establish, although newer narrative and ethnographic research approaches are being increasingly pursued. These qualitative studies have provided a deeper analysis and understanding of the more classical scientifically based quantitative findings. Taking the above factors into account, the research indicates that:

- student academic achievement improves with improved building condition;
- individual factors, such as lighting levels, air quality and temperature and acoustics, have an effect on student behaviour and outcomes, although there is limited quantitative evidence available on some of these factors; and,
- new and emerging trends in school building planning and design and their impact on student outcomes and behaviour have yet to be evaluated using a rigorous research methodology.

### **LAUSD School Facilities and Academic Performance**

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A good school facility supports the educational enterprise. Research has shown that clean air, good light, and a small, quiet, comfortable, and safe learning environment are important for academic achievement (see, for example, Cash 1993, Earthman and Lemasters 1996, Lemasters 1997, Lackney 1999, Cotton 2001, Schneider 2002). While factors such as student socioeconomic status and parental involvement are among the most important predictors of student academic performance, the condition, adequacy and management of a school building are directly under the control of the school district and state—hence improving school facilities offers a feasible opportunity for improving academic performance. In this report we study the relationship between the extent to which schools in the Los Angeles Unified School District (LAUSD) comply with health and safety regulations and academic performance, as measured by California's API.1

### **School Facilities Improve Learning**

*For more information, contact the California Department of Education, School Facilities Services Division, at 916-322-2470*

There is a growing body of research demonstrating that clean air, good light, and a small, quiet, comfortable, and safe learning environment are important for students' academic achievement. Here are a few examples of the research results:

- Students who receive instruction in buildings with good environmental conditions can earn test scores that are 5–17 percent higher than scores for students in substandard buildings.
- There is a negative relationship between classroom noise higher than 40 decibels and student achievement.
- Schools with better building conditions have up to 14 percent lower student suspension rates.

- Improving a school's "Overall Compliance Rating" to meet health and safety standards can lead to a 36-point increase in California Academic Performance Index scores.
- Substandard physical environments are strongly associated with truancy and other behavior problems in students. Lower student attendance led to lower scores on standardized tests in English–language arts and math.
- Students' reading speed, comprehension, and mathematics performance are adversely affected by room temperatures above 74 degrees.
- Student achievement scores tend to decrease as the school building ages—to as high as 9 percent, depending on maintenance factors.
- Studies indicate that student performance is improved by an even distribution of daylight, an expansive view, and limited glare and thermal heat gain. One study found 20 percent faster student progress on math and 26 percent faster progress in reading compared with students in classrooms with less exposure to daylight.

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

*Carol Cash, Travis Twiford. This work is produced by The Connexions Project and licensed under the Creative Commons Attribution License. <http://cnx.org/content/m23100/1.2/>*

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.

### **The impact of the classroom built environment on student perceptions and learning**

*Gwen C. Marchand, Nicholas M. Nardi University of Nevada Las Vegas, Department of Educational Psychology and Higher Education. Douglas Reynolds, Stoil Pamoukov, University of Nevada Las Vegas, Center for Mechanical Environmental Systems Technology, Thomas T. Beam College of Engineering. Available online 5 July 2014. Journal of Environmental Psychology 40(2014)187 e197, journal homepage: [www.elsevier.com/locate/jep](http://www.elsevier.com/locate/jep) ©2014 Elsevier Ltd. All rights reserved.*

The aim of this experimental study was to investigate whether the combined environmental factors of light, sound, and temperature in a classroom built environment set to comfortable levels or just outside the comfort zone (OCZ) impacted undergraduate student learning, mood, and perceptions of environmental influence on performance during listening and reading tasks. Results indicated that participants in the OCZ listening condition had lower scores on a comprehension test than those in the normal listening condition, but that no difference was detected between conditions for the reading modality. Students in the OCZ condition reported more negative affect and believed that the sound and temperature of the room had a more negative impact on their performance than those in the normal condition. Participants in the reading conditions were more likely to attribute poor performance to the sound levels in the room than students in the listening condition.

### **Investing in Schools: Capital Spending, Facility Conditions, and Student Achievement**

*Paco Martorell - UC Davis, Isaac McFarlin Jr. - University of Michigan, Kevin Stange - University of Michigan NBER, February 2015*

Public infrastructure investments in repairs, modernization, and construction of schools cost billions. However, little is known about the nature of school facility investments, how funding is allocated within school districts, whether it actually changes the physical condition of public schools, and the subsequent causal impacts on student achievement. We study achievement effects of nearly 1,400 capital campaigns initiated and financed by local school districts. To overcome the concern that school districts conducting campaigns are different from districts that do not, we exploit the fact that the bonds used to finance the campaigns require voter approval and compare districts where bond referenda in close elections narrowly pass and fail. Overall, we find little evidence that school capital campaigns improve student achievement. Further exploration reveals that although capital campaigns lead to school openings and physical improvements in school environments, the change in conditions experienced by the typical student is modest. Thus, U.S.

school capital campaigns financed by local districts, the pre-dominant method through which facility investments are made, may be a limited tool for realizing substantial gains in student achievement or closing achievement gaps.

### **Building minds, minding buildings: Turning crumbling schools into environments for learning**

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Nearly 20 years ago the American federation of Teachers called for a “Marshall Plan” for urban schools, pointing out that the infrastructure of cities had deteriorated as federal funds were sharply reduced. Existing school buildings were crumbling and new schools were not being built. This problem has now spread far beyond the boundaries of urban school districts and touches nearly every school system in our nation. Staff in these schools struggle to educate students in conditions that few corporations, much less building inspectors, would tolerate. Mold, leaking ceilings, extreme temperatures, raw sewage seeping into hallways, mice droppings, severely overcrowded classrooms—these unhealthy and/or unsafe conditions plague tens of thousands of old and new school buildings where millions of Americans age 5 and older must study and work. For the most part, officials have been unwilling to adequately confront this serious situation, which is affecting teaching and learning. The AFT has long championed higher standards and greater accountability. We believe that these principles must be reflected not only in high-quality teaching and a challenging curriculum, but also in the planning, design, construction, maintenance and operation of our nation’s schools. We continue to believe that the school environment cannot be separated from the academic agenda. The U.S. Department of Education under the Bush administration commissioned a study (called for in 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.” The study found “the overall evidence strongly suggests that poor environments in schools, due primarily to effects of indoor pollutants, adversely influence the health, performance, and attendance of students.” Sadly, the department shelved the study’s unpleasant results. Our report focuses on the problem of inadequate, unhealthy and unsafe public school building conditions; the consequences of poor conditions on learning, health and staff retention; the elements of well-designed, well-built, well-maintained schools; and recommendations for action at all levels to improve school buildings.

### **Does High School Facility Quality Affect Student Achievement? A Two-Level Hierarchical Linear Model**

*Alex J. Bowers and Angela Urick. Journal of education finance | 37:1 summer 2011*

The purpose of this study is to isolate the independent effects of high school facility quality on student achievement using a large, nationally representative U.S. database of student achievement and school facility quality. Prior research on linking school facility quality to student achievement has been mixed. Studies that relate overall independently rated structural and engineering aspects of schools have been shown to not be related to achievement. However, more recent research has suggested that facility maintenance and disrepair, rather than structural issues, may be more directly related to student achievement. If there is a relationship, addressing facility disrepair from the school, district, or state level could provide a potential avenue for policymakers for school improvement. We analyzed the public school component and the facilities checklist of the ELS: 2002 survey (8,110 students in 520 schools) using a two-level hierarchical linear model to estimate the independent effect of facility disrepair on student growth in mathematics during the final two years of high school controlling for multiple covariates at the student and school level. We found no evidence of a direct effect of facility disrepair on student mathematics achievement and instead propose a mediated effects model.

### **Do School Facilities Affect Academic Outcomes?**

*Mark Schneider, November 2002. National Clearinghouse for Educational Facilities. [www.edfacilities.org](http://www.edfacilities.org)*

On any given school day, about twenty percent of Americans spend time in a school building. The average age of our schools is close to fifty years, and studies by the U.S. General Accounting Office have documented widespread physical deficiencies in many of them. Faced with an aging building stock and growing, shifting student enrollments, states and communities are working hard to build and modernize K–12 facilities. Those involved in school planning and design see this as an opportunity to enhance academic outcomes by creating better learning environments. Their logic is compelling—how can we expect students to perform at high levels in school buildings that are substandard? We all know that clean, quiet, safe, comfortable, and healthy environments are an important component of successful teaching and

learning. But which facility attributes affect academic outcomes the most and in what manner and degree? A growing body of research addresses these questions. Some of it is good, some less so; much of it is inconclusive. The research is examined here in six categories: indoor air quality, ventilation, and thermal comfort; lighting; acoustics; building age and quality; school size; and class size.

## **The Interface Among Educational Outcomes and School Environment**

*C. Kenneth Tanner*

Linking measurements of the physical environment's physiognomies to human behavior and productivity is a rather new task in the fields of education, and social and natural sciences. In education; for example, how can a schoolhouse and its surroundings be measured such that valid and reliable comparisons can be made among student outcomes? For example, how do school environments influence student behavior and other outcomes? How do we quantify specific features of the physical environment of the school? Obviously, we already accept the quantification of student testing and other measurable outcomes based on our continual dependence on standardized tests for making decisions. The article approaches this issue through rules of consistent measurement and mapping practices. Three common measurement scales, nominal, ordinal, and interval scales are compared. The nominal scale is shown to be of unequivocally no value in making quantitative comparisons, beyond classifying and categorizing assigned values. The ordinal and interval scales may be considered as vectors having magnitude and direction, while the nominal scale does not fit into correlations, regression, and prediction equations because the nominal classification cannot show direction or specify magnitude. Examples of the use of ordinal and interval scales are presented with respect to comparisons of student outcomes and measured environmental variables having magnitude and direction.