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Effects of Day-Lighting in Schools on Student Performance and Well-Being

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An Introduction to ATINER's Conference Paper Series

ATINER started to publish this conference papers series in 2012. It includes only the papers submitted for publication after they were presented at one of the conferences organized by our Institute every year. The papers published in the series have not been refereed and are published as they were submitted by the author. The series serves two purposes. First, we want to disseminate the information as fast as possible. Second, by doing so, the authors can receive comments useful to revise their papers before they are considered for publication in one of ATINER's books, following our standard procedures of a blind review.

Dr. Gregory T. Papanikos
President
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Abstract

School districts throughout the country seek measures to improve test scores, reduce school absenteeism, improve Indoor Environmental Quality (IEQ), and respond to shrinking Facility Management and teacher salary budgets. There is a need to identify key building investments that will provide the highest benefits to children, teachers, and the community. The research examines 185 built environment characteristics, identified in one of three categories: Physical Conditions, Occupant variables, and Indoor Environmental Quality (IEQ) variables with seven (7) health and performance metrics: suspension rates, student absenteeism, weight, asthma, and academic performance specifically focusing on day-lighting issues and benefits. Among the numerous benefits of providing sustainable schools with higher test scores through retrofitting of school facilities are an increased community image and perception, improved teacher retention, the ability to secure additional funding through grants, and an improved health and well-being of the school's occupants.

This effort is part of an on-going effort of the Energy Efficient Buildings (EEB) Hub to improve energy efficiency in buildings and promote regional economic growth and job creation.

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Introduction

Humans are a part of nature. We evolved in the natural environment, yet today we spend the vast majority of our time indoors. For about 1/5 of the United States, over 1,200 hours every year are spent in a school building. Schools are four times more densely occupied than offices.[1] In 2010, nearly 50 million (49.5) students attended public elementary and secondary schools and the public school system employed about 3.3 million individuals (teachers, principals, librarians, etc.).[2] Likewise, around a fifth of the entire US population (roughly 53 million people spends the majority of their waking hours during the school year in a public school building. The vast majority of these occupants are youth in their prime developmental years.

Poor building conditions impact teacher retention and student test scores. One major aspect of nearly every building, day-lighting, has been shown to improve these conditions, having tremendous benefits over electric lighting in terms of human health, student performance, and additionally, building energy use. Schools are most intensely used during the hours when the sun is shining, yet up to 40% of their electricity use goes towards powering artificial illumination.[3] Over 90% of classrooms are artificially lit even when rooms are unoccupied, wasting both energy and funds. Annually, America's schools spend over $6 billion on energy, more than on textbooks and computers combined (see Figure 1).[4] It is necessary to improve the quality of the environment in which our students learn and our teachers work so that equal opportunities for student success and optimal scenarios for teacher effectiveness are created.

Most schools lack proper components and controls to maximize day-lighting. Furthermore, many schools in all different climates have gone to great lengths to block daylight partially or completely. Many schools were originally designed to be day-lit, but today the original day-lighting scheme is rarely evident —with items on windows, shutting out not only daylight but a view outside, a connection recognized as calming and stress-reducing.

School building conditions affect teacher effectiveness, morale, and retention. Good buildings attract good teachers. Additionally, dissatisfied employees do not perform optimally. A decrease in teacher performance can have a negative impact on their ability to deliver instructional material. When

[1] New Jersey Work Environmental Council. (2002). *Heathly Schools in New Jersey. Preventing Hazards to Students, School Employees, and Construction Workers.*

[2] U.S. Department of Education, National Center for Education Statistics. (2012). *Numbers and Types of Public Elementary and Secondary Schools From the Common Core of Data: School Year 2010–11* (No. NCES 2012). Retrieved from http://nces.ed.gov/pubs2012/2012325.pdf

[3] CHPS, Inc. (2006). Best Practices Manual, 2006 Edition (Vol. Volume II:Design for High Performance Schools). California Criteria for High Performance Schools. Retrieved from http://www.chps.net/dev/Drupal/node/288

[4] Goggio Borgeson, M., & Zimring, M. U.S. Department of Energy, Lawrence Berkeley National Laboratory. (2013). *Financing Energy Upgrades for K-12 School Districts: A Guide to Tapping into Funding improvements.* Retrieved from website: http://emp.lnl.gov/sites/all/files/lbnl-6133e.pdf

teachers are dissatisfied with their school environment, they might consider changing schools or leaving the profession entirely.

While funding remains the largest issue facing many districts today, many public schools in districts all over the U.S. have found the means to improve or introduce daylight in schools that are decades—even centuries—old. Green energy grants, staged renovations, and measured energy use reduction are all helping to facilitate daylight improvements in districts across the nation. Improving day-lighting conditions in a school building depends heavily upon construction, form, orientation, and location—among other factors.

Methodology

One hundred eighty five physical variables were identified as potentially impacting student health and performance. The identification was based on literature reviews, interviews with Educational Professionals, and available data from governing agencies. Eight (8) physical conditions were identified as daylight and views variables; Building Shape, Building Orientation, Building Depth, Proximity of Adjacent Property, Window to Wall Ratio, Window Type, Window Exterior Guard Type, and Shading Device types. Each variable condition was identified for 120 schools using various coding methods to quantify qualitative data. As an example, 120 schools were identified and classified into one of 16 basic layout designs. A preliminary analysis of the 16 building types was conducted to identify their impact on performance and health, however the results were not conclusive.

In an effort to focus on the built environment attributes that most impacted student health and performance, HS and MS were removed from the dataset. HS and MS students contain an increased number of confounding factors that impact their health and performance. Additionally, elementary school students are more likely to spend the majority of their time in one to two classrooms throughout the day. This stationary tendency reduces possible influence from multiple physical environments and provides a greater possibility to draw conclusions that link their environment to health and performance metrics.

Initial school and neighborhood characteristics were identified based on virtual images; photographs and data from the New York City Department of Education's Building School Facility Reports; the NYC Department of Education's Building Condition Assessment Survey, the NYC Department of Parks & Recreation, and the City of Yonkers Parks & Facilities. Additionally, school building and departmental procedures were also obtained from literature reviews, professional experience, empirical knowledge, and interviews with Teachers, Principals, Custodians, and Facility Managers.

Student performance was accessed based on results of state standardized tests for multiple school years. Based on the 2007 New York State Public Schools Report Card, statewide testing was available for select grades. Math and ELA testing begins in the 3rd grade, however, Science testing begins in the 4th grade and Social Studies was only tested in the 8th grade. Additionally, class size availability was available for two grades, 8^{th} and 10th. The report also includes various statewide statistics such as suspension, absenteeism, teacher turnover, and graduation rates.[1] Based on available NY State data and the goal to focus on physical environmental characteristics that are linked to student health and performance, fourth grade tests scores were utilized to access student performance.

School test scores are typically identified as the number and the percent of students whose score meets the requirements at one of four levels. Since Level 3 is the minimum, required to meet proficiency, built environmental characteristics were evaluated based on their relationship to the percentage of students at a particular schools 4^{th} grade level whose scores were at levels 3 or 4.

Similar research was conducted for Pittsburgh, Pennsylvania City Schools. Visits were made to each school in the district to collect visual information for analysis. The key data sets collected were concerned were 8 types of daylight obstruction which included blocked high windows, blocked view windows, metal mesh on windows, no/low visibility glazing, low glazing area, ideal orientation, and window blocked with material i.e. paper. Likewise, extensive compilations and analysis were performed of the Commercial Building Energy Consumption Survey (CBECS) detailing the primary use of fuel energy.

Current School Conditions

Based on the characteristics of the existing school building stock, the potential for day-lighting through side-lighting (windows) in schools across the United States is great.. Nationally, the vast majority of schools in use today are over 40 years old and were built to allow ample day-lighting.

Three-quarters of America's existing schools were built before 1970. Larger, older cities have greater numbers of older schools. In Pittsburgh, for instance, around 70% of schools were built before 1945. Older schools are actually well-suited for sustainable renovations—particularly for improving day-lighting. Sadly, poorly planned renovation decisions, first-cost decision making, lack of whole-building energy considerations, and deferred maintenance over the decades have put many of these buildings in a condition that only vaguely resembles that of their original design logic and aesthetic splendor. Today many windows are covered, restricting daylight from entering mostly or entirely. In fact, most schools report that 0-10% of their building area is utilizes daylight (see figure 2).[2] Since many of the buildings contain long facades facing east and west, the low sun angles and lack of exterior shading devices can cause significant glare. Unfortunately, many schools utilize opaque shades that block sunlight and view, therefore rooms with large windows may have reduced daylight due to the shading devices. Many of the schools in

[1] NYSED. (2006-07). *Office of Information and Reporting Services.* Retrieved February 2009, from New York State Public Schools Report Card: http://www.emsc.nysed.gov/irts/reportcard/.
[2] CBECS Public Use Microdata

Pittsburgh with ample day-lighting opportunities were found to have multiple methods of daylight obstruction such as metal meshes or the windows being blocked entirely (see Figure 3).

In 1999, the *Condition of America's Public School Facilities* (the most recent major, comprehensive report on the condition of our schools' infrastructure) found that nearly three quarters of school facilities at that time were in need of 'repairs, renovations or modernization in order to reach *good* condition.'[1] A 1995 report by the General Accounting Office stated that 25,000 public schools need extensive repair and replacement, concluding that the air is 'unfit to breathe' in roughly 15,000 schools.[2]

Impacts on Health and Performance

In many New York City schools, students are not proficient in English, math, sciences, and social studies, barley reaching a 50% passing rate (see Figure 4). With the proven dramatic benefits of day-lighting on student performance, it would make sense to investigate how to improve the day-lighting conditions in all schools.

Given the implicit goal of improving every student's performance,, it becomes extremely necessary to address the many issues causing students to not perform below optimal level. Day-light access and quality has the potential to impact student learning. The research also identified the quality of the window as a possible contributor to student academic performance. Based on an ANoVA analysis of the previously mentioned 185 physical varibales, the condition of the window was shown to have a significant relationship with 4th grade test scores. Other examples of improved performance include studies performed on two daylit middles schools in North Carolina which showed an average increase of 12.5% in test scores compared to the county wide average of only 5%. Between 1992 (the first year students were in anew daylit facility) and 1995, students' End-Of-Grade test scores rose faster than the county average (although the whole county improved during this time period, these students made greater improvements). Average Reading/Math scores showed 1.5% and 5.2% improvement rates, respectively, whereas the non-daylit schools showed a negative 1.6% improvement rate.[3]

The most important study to date showing the correlation between day-lighting and student performance found that students with the most day-lighting in their classrooms progressed 20 percent faster on math tests and 26

[1] National Center for Education Statistics. (2000, June 21). Condition of America's Public School Facilities: 1999. Retrieved June 3, 2012, from http://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2000032

[2] United States General Accounting Office. (1995). *SCHOOL FACILITIES: Condition of America's Schools* (Report to Congressional Requesters No. GAO/HEHS-95-61). Washington, D.C.: prepared by the Health, Education and Human Services Division.

[3] Nicklas, M., & Bailey, G. (1997). Analysis of the Performance of Students in Daylit Schools. http://www.innovativedesign.net/papers/papers.htm

percent [faster] on reading tests in one year than those with the least amount of day-lighting in their classrooms.[1] 'Similarly, students in classrooms with the largest window areas were found to progress 15 percent faster in math and 23 percent faster in reading.'[2]

Improving daylight can also help minimize teacher turnover rate and reduce student and teacher absences. In terms of building geometry, finger building layouts provide the greatest opportunity for day-lighting classrooms and therefore the highest-quality learning environments. The finger plan layout maximizes day-lighting while at the same time minimizes acoustical problems because of the division of classrooms into separate wings (see Figure 5). This geometry design (given proper solar orientation) can be associated with reduced teacher turnover rates and a subsequent increase in student performance. While there are several limitations, the research on NYC schools with 30% fenestration have the lowest teacher turnover. This could be attributed to the age and condition of buildings with 40-50% fenestration or a teacher's ability to control glare. It is possible that at 30% fenestration, teachers are able to balance thermal comfort desires, control glare, and have less acoustical intrusions than at 50% fenestration.

In a research study in Texas, teachers' response to questionnaires showed that those in buildings with poor conditions felt that it had a negative impact on the learning climate, while those in buildings in good condition felt it had a positive influence on the learning climate. In another study, teachers were questioned about their feelings on their morale and the learning environment before, during, and after a renovation project. The findings showed that teacher morale and their perception on the learning environment improved after the renovations. Finally, a study of teachers in urban schools reported that the 'working condition of urban teachers is marginal and would not be tolerated by any other profession.'[3]

Many studies have shown that buildings with daylight have a positive impact on different aspects of occupants' health. Benefits range from preventing eye strain to regulating sleep and other biological cycles to positively effecting students with seasonal effective disorder (SAD). There are two distinctly different systems through which daylight affects humans: the Visual System and the Circadian System. Both systems are vitally important for students important for students in a learning environment, and both are highly affected by daylight

Daylight has the potential to minimize headaches and eyestrain as it better matches with the human visual sensitivity as our eyes developed around

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[1] Heschong-Mahone Group. (1999). *Daylighting in Schools: An Investigation into the Relationship between Daylighting and Human Performance.* (Detailed Report). Retrieved from http://www.eric.ed.gov/PDFS/ED444337.pdf

[2] Cooper, Kenneth, K. 'Study says natural classroom lighting can aid achievement.' Washington Post, November 26, 1999: A14.

[3] Earthman, Glen I. School facility conditions and student academic achievement. Virginia Polytechnic Institute and State University, UCLA/IDEA Publication Series Document wws- rr008- 1002, 2002.

daylight, not artificial light. Daylight also does not have the dramatic spikes associated with artificial lighting such as fluorescent lights.

Human beings have evolved for millennia in synch with natural light-dark cycles, entirely based on the rising and setting of the sun. Biological processes in every species have been entrained by this 24-hour cycle. These processes are referred to as the circadian system. The exposure to the fluctuations of bright light during the day and darkness at night helps keep these cycles consistent. It is important that they be kept regular as they are essential to many aspects of human health, regulation such components as our alertness, concentration, digestion, sleep, and cell cycles. The color rendering capability of daylight is also important in a learning setting because it impacts aspects of how space is interpreted as well as the teaching/learning process. A 1981 study by Sinofsky and Knirck found that color influences student attitudes, behaviors and learning.[1]

Daylight also has the potential to help reduce stress in both teachers and students by connecting them to the outdoors. Experience tells us that humans have a preference to be seated next to windows for the purpose of a view, but research also shows that building occupants with a view through a window (especially one with natural content) are measurably happier and also perform better.[2]

This connection to the outdoors (both physically and visually) has a impact on student obesity. A close connection to green spaces and parks is linked with reducing weight, as students have easier access to the outdoors and exercise. Physical fitness (and weight), in turn, are associated with student performance and test scores. Studying students in New York City for grades 4-8 showed a 30% improvement in test scores for the top third in fitness regardless of race and 17% improvement for the middle third compared to the bottom third in fitness.

Proximity to parks can provide numerous health and learning benefits. In addition to a pleasant view, parks provide the potential to improve learning and weight as obesity also has an impact of students' ability to learn. Neighborhood schools within walking distance to 5 acre parks or larger have decreases rates on community obesity and overweight percentage ($p<.05$).

Solutions/Retrofits

When it comes to day-lighting and schools, almost every school has room to make improvements. Aspects such as orientation, floor plate geometry, and glazing area are major factors in determining the extent to which day-lighting can be used, and these factors can be manipulated to improve day-lighting in existing schools. Every school is unique, so improving day-lighting will depend on starting condition; however, there are definite trends in how daylight

[1] Sinofsky, F.G., & Knirck, E.R. (1981). Chose the right color for your learning style. Instructional Innovator, 26(3), 17-19.

[2] Dasgupta, U. (2003). The Impact of windows on performance of judgemental tasks. 159.

has been blocked or compromised that are unique to different architectural generations of schools.

The key components to proper design or retrofit of schools is based on eight key day-lighting features: building shape, building orientation, building depth, proximity of adjacent properties, window to wall ratio, window type, window exterior guard type, and shading devices. Each factor impacts the potential for day-lighting to help improve student and teacher performance.

For improving pre-World War II schools, a key aspect is adjusting possible retrofits that have occurred that are minimizing the sustainable potentials of the classrooms. Many of these classrooms have large portions being covered by the ceiling. Adjusting the ceilings to allow full access to the windows to let in ample daylight as well as provide views to the outside. If certain portions of the ceiling still need to be dropped down, slopping the ceiling near the windows to allow the full height to be open is an ideal solution (see Figure 6).

For any era of school an important aspect of day-lighting classrooms is not only the window area (including height and width), but the classroom depth as additional light reflection devices such as light shelves might be necessary to bounce light all the way into the space. Light shelves can also be designed to bounce light into the space through the use of white ceilings as well as be used to block the harsh solar gains of the summer yet allowing those ideal gains in the winter reducing the loads of the HVAC equipment (see Figure 7). These light shelves are integral for new schools were large windows that are present in older schools are not as present. Maximizing what daylight is available is the key to retrofitting schools.

Room organization also impacts daylight and other factors. Appropriate wall, partition, window, and furniture organization can increase the spacious feeling of a room, provide additional open space for various activities, and reduce eye and voice strain. Also integrating the daylighting with electronics as well helps to reduce glare and eye strain (see Figure. 8). By not blocking windows, daylight can be more evenly distributed within the space.

Pre-World War II School Buildings:

Step 1: Maximize daylight through windows.

Step 2: Maximize view through windows.

Step 3: Use redirection and shading devices and glazing properties based on solar orientation and window location.

Step 4: Improve room finishes and furniture layout such as colors and arrange furniture to not block daylight.

Step 5: Ensure that users know how to use daylight design components and that components are user friendly, i.e. place the row of lights closer to the windows on separate switches.

Step 6: Integrate day-lighting with electric lighting i.e. daylight sensors so that lights are only used when there is not sufficient light.

Mid-Century Schools:

Step 1: Add exterior shading to stop direct light and soften daylight.

Step 2: Restore window openings by removing opaque coverings i.e. plywood, solid shades, posters, etc.
Step 3: Improve room finishes and furniture layout such as colors and arrange furniture to not block daylight.
Step 4: Ensure that users know how to use daylight design components and that components are user friendly, i.e. place the row of lights closer to the windows on separate switches.
Step 5: Integrate day-lighting with electric lighting i.e. daylight sensors so that lights are only used when there is not sufficient light.

Late Modern Schools:

Step 1: Enlarge or create glazed openings while improving glazing properties and adding shading.
Step 2: Add top-lighting such as skylights, light wells, technology that transports light.
Step 3: Improve room finishes and furniture layout such as colors and arrange furniture to not block daylight.
Step 4: Ensure that users know how to use daylight design components and that components are user friendly, i.e. place the row of lights closer to the windows on separate switches.
Step 5: Integrate day-lighting with electric lighting i.e. daylight sensors so that lights are only used when there is not sufficient light.

Conclusion

Day-lighting schools can help free up funds for education materials like textbooks and computers. Lighting energy is the largest quantity of source energy and the second largest consumer of site energy, behind heating. Day-lighting can help reduce heating loads as properly designed windows can bring in solar gains in the winter. Integrating overhangs and light shelves can help block direct solar gains in the summer reducing cooling loads while still allowing beneficial solar gains in the winter. Operable windows can increase ventilation meaning less reliance on mechanical equipment. Utilizing natural day-light means less electrical lighting is needed.

The benefits of daylight inside of a building in the realms of human health, productivity, and energy are so numerous, it is almost unbelievable. Health, academic performance, and teacher retention can all be impacted by access to daylight the subsequent quality from views, glare quality, acoustics, and window condition. In a building type which houses our world’s most susceptible minds and bodies, we should be doing everything we can to provide every physical and psychological advantage possible.

Figures

Figure 1. *Total Consumption and Gross Energy Intensity for Sum of Major Fuels*[1]

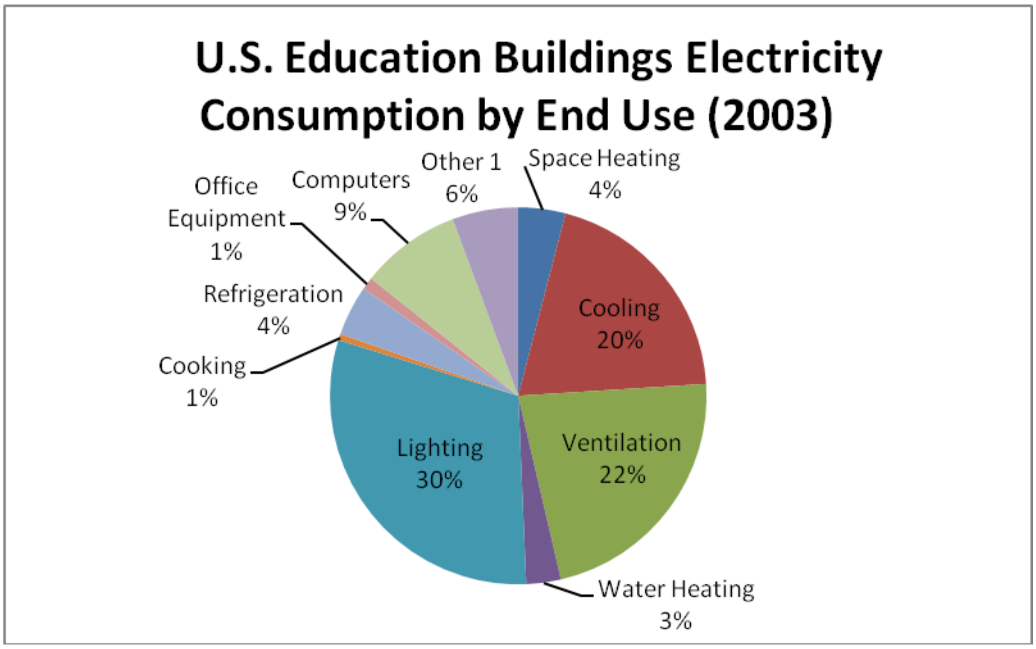
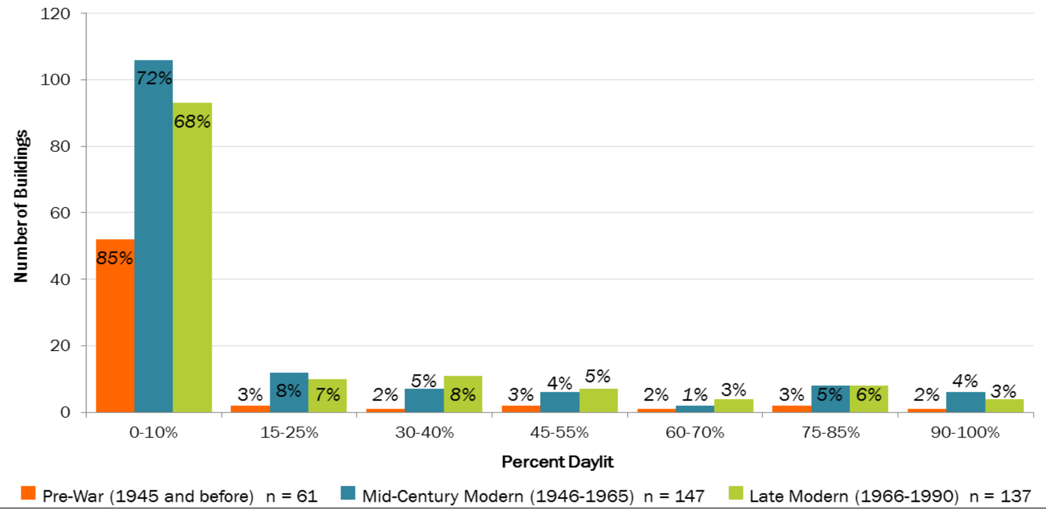


Figure 2. *Area of school building in U.S. reported to be daylit*[2]



[1] CBECS Public Microdata
[2] CBECS Public Microdata

Figure 3. *Frequency and Methods of Daylight Obstruction in Pittsburgh Public Schools*

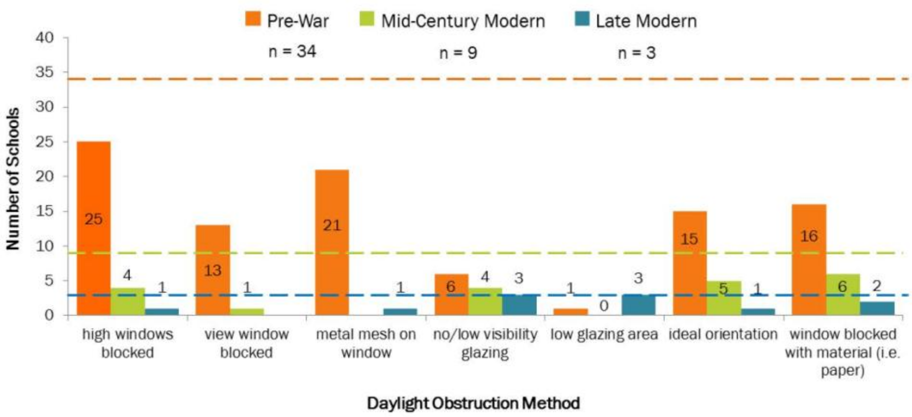


Figure 4. *8th Grade Student Profiency in New York City Schools*

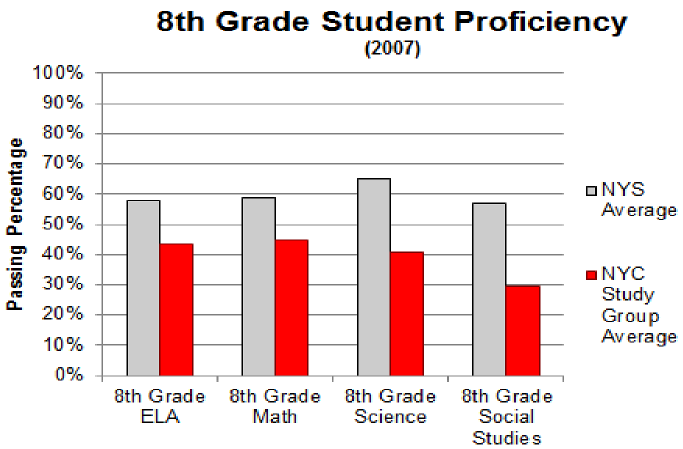
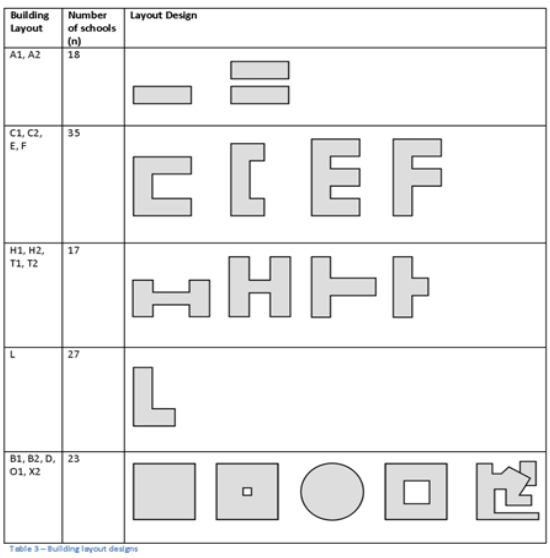


Figure 5. *Layout and Number of Schools in New York Study Group*



Building Layout	Number of schools (n)	Layout Design
A1, A2	18	
C1, C2, E, F	35	
H1, H2, T1, T2	17	
L	27	
B1, B2, D, O1, X2	23	

Table 3 – Building layout designs

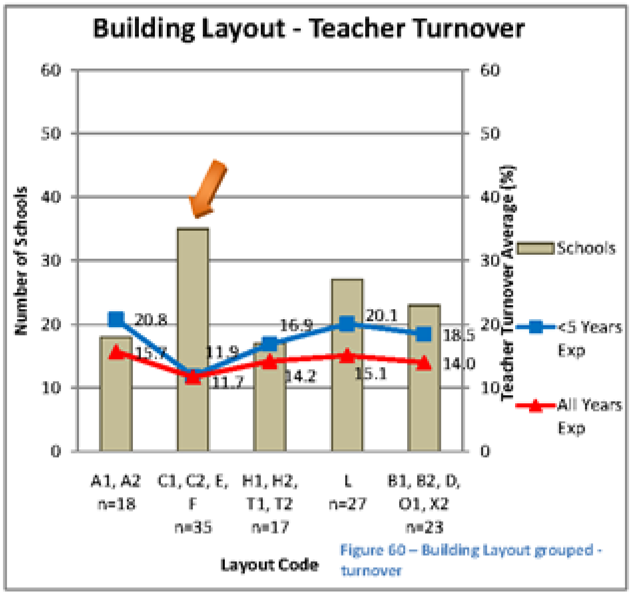


Figure 6. *Drop Ceiling Adjustments to Maximize Daylight*

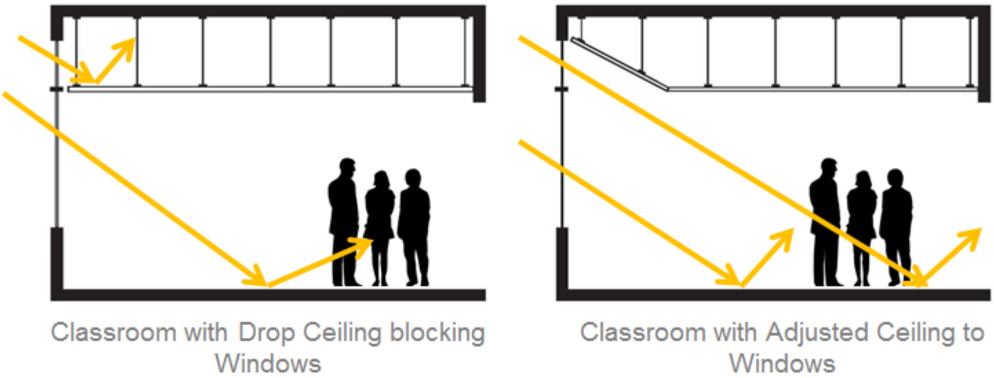


Figure 7. *Light Shelves to Maximize Daylight in Deep Spaces*

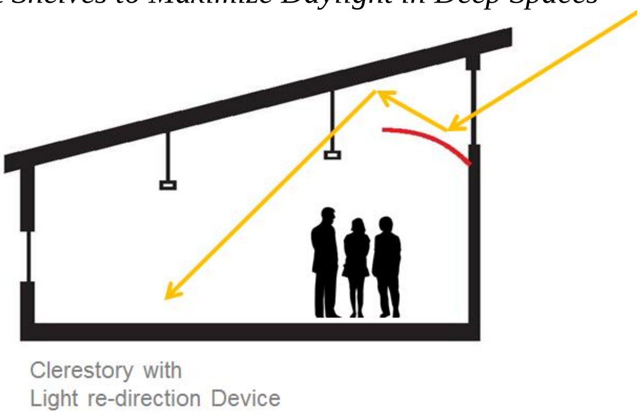


Figure 8. *Shading Device to Prevent Glare on Projection Screens*

Bibliography

CBECS Public Use Microdata

CHPS, Inc. (2006). Best Practices Manual, 2006 Edition (Vol. Volume II:Design for High Performance Schools). California Criteria for High Performance Schools. Retrieved from http://www.chps.net/dev/Drupal/node/288

Cooper, Kenneth, K. 'Study says natural classroom lighting can aid achievement.' Washington Post, November 26, 1999: A14.

Dasgupta, U. (2003). The Impact of windows on performance of judgemental tasks. 159.

Earthman, Glen I. School facility conditions and student academic achievement. Virginia Polytechnic Institute and State University, UCLA/IDEA Publication Series Document wws-rr008-1002, 2002.

Goggio Borgeson, M., & Zimring, M. U.S. Department of Energy, Lawrence Berkeley National Laboratory. (2013). *Financing Energy Upgrades for K-12 School Districts: A Guide to Tapping into Funding improvements.* Retrieved from website: http://emp.lnl.gov/sites/all/files/lbnl-6133e.pdf

Heschong-Mahone Group. (1999). *Daylighting in Schools: An Investigation into the Relationship between Daylighting and Human Performance.* (Detailed Report). Retrieved from http://www.eric.ed.gov/PDFS/ED444337.pdf

National Center for Education Statistics. (2000, June 21). Condition of America's Public School Facilities: 1999. Retrieved June 3, 2012, from http://nces.ed.gov/ pubsearch/pubsinfo.asp?pubid=2000032

New Jersey Work Environmental Council. (2002). *Heathly Schools in New Jersey. Preventing Hazards to Students, School Employees, and Construction Workers.*

Nicklas, M., & Bailey, G. (1997). Analysis of the Performance of Students in Daylit Schools. http://www.innovativedesign.net/papers/papers.htm

NYSED. (2006-07). *Office of Information and Reporting Services.* Retrieved February 2009, from New York State Public Schools Report Card: http://www.emsc. nysed.gov/irts/reportcard/.

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U.S. Department of Education, National Center for Education Statistics. (2012). *Numbers and Types of Public Elementary and Secondary Schools From the Common Core of Data: School Year 2010–11* (No. NCES 2012). Retrieved from http://nces.ed.gov/pubs2012/2012325.pdf

United States General Accounting Office. (1995). *SCHOOL FACILITIES: Condition of America's Schools* (Report to Congressional Requesters No. GAO/HEHS-95-61). Washington, D.C.: prepared by the Health, Education and Human Services Division.