SUMMARY

The following document provides an annotated bibliography of articles, reports and studies currently available in the Office of School Modernization library. The bulleted summaries highlight subject matter of interest, research methodology and relevant conclusions.

The bibliography is broken into two sections, one that encompasses various facilities conditions factors and their researched effect on student achievement and one that focuses primarily on factors pertaining to sustainability.

These studies:

- Project a 5-17% (10% average) impact of facilities conditions on student achievement
- Examine a range of facilities conditions factors, including: indoor air quality, thermal comfort, lighting (electric and day), roofing, custodial staff, portable classrooms, classrooms style and size, school size, building age, teacher perception of classroom spaces, students' school pride and outdoor recreational learning environments, among others.

This bibliography includes the following articles:

**FACILITIES CONDITIONS**

- Research on the Impact of School Facilities on Students and Teachers: A Summary of Studies Published Since 2000
- The Importance of Place: Facility Conditions and Learning Outcomes
- Schoolyard Improvements and Standardized Test Scores: An Ecological Analysis
- School Facility Conditions and Learning Environments: Canadian Evidence
- Connecting Facility Conditions to Learning Outcomes: A Review of the Literature
- LAUSD School Facilities and Academic Performacne
- Do School Facilities Affect Academic Outcomes?
- The Effects of Inadequate School Infrastructure on Student Performance
- School Facility Conditions and Student Academic Achievement
- Do School Facilities Really impact a Child's Education?
- A Synthesis of Studies Pertaining to Facilitties, Student Achievement and Student Behavior

**SUSTAINABILITY**

- Windows and Classrooms: A Study of Student Performance and the Indoor Environment
- Green, High Performance Schools
- Greening America's Schools: Costs and Benefits
- Sustainable K-12 Schools
- National Review of Green Schools: Costs, Benefits and Implications for Massachusetts
- A Synthesis of Studies Pertaining to Facilitties, Student Achievement and Student Behavior

Please contact Sarah Oaks at soaks@pps.net or 503.916.3796 with any questions or to receive copies of these documents.
RESOURCES BASED ON FACILITIES CONDITIONS:


- Spreadsheet summary of studies published on public school facilities impact on student achievement
- **Positive relationship**: evidence points to “small but steadily positive” relationship between the quality of a school facility and a range of academic and community outcomes.
- **Published studies**: facilities & academic outcomes, school building systems, school facility condition & community factors


- Summarizes 400 studies suggesting 5-17% (10% avg.) *indirect* impact of facilities on student achievement
- **Social climate**: learning environment or “social climate”—morale, commitment, pride of place, enthusiasm— which *directly* impacts achievement, is supported or hindered by facilities conditions
- **Inert Properties**: Emphasizes attitude of schools being seen as unimportant rather than central to academic mission, which enables constant deferral of money from maintenance and upkeep to curriculum. Money deferred in this manner is not “saved” because of the issues it creates.
- **PISA Study**: Cites corresponding results of student’s performance on PISA (Canadian standardized test) and 1,100 principals’ answers to questions about student & teacher commitment and facilities: school buildings and grounds, heating/cooling & lighting, instructional space.
- **Four Facilities Propositions**: recommends better pedagogical functionality (structural building systems), programmatic suitability (classroom facilities), cosmetic appropriateness and participant wellness


- Ecologic study comparing 4th grade test score results in schools with renovated vs. unrenovated schoolyards
- **Outdoor Spaces**: conducted after ½ of Boston, MA’s schools had received renovated *outdoor recreational learning* and garden spaces
- **Math Improvement**: Controlled for demographics, schools with renovated schoolyards had more students pass the state mandated math test. Effects on English not as pronounced.
- **Physical Improvements**: Study suggests that improvement of physical environment of schools and better access to physical activity may result in better student performance, recommends further study

- Results of PISA Study and summary of principal’s responses to questions about student & teacher commitment and facilities: school buildings and grounds, heating/cooling & lighting, instructional space.
- “Substantial and manageable”: study conducted because facilities conditions area determinant of student success and something that can be actively controlled by the district
- Direct vs. Indirect: Students in better facilities had more enjoyment at and pride for their schools, as well as more enthusiasm and value for academic achievement
- Non-Linear: results sorted into 4-tiers based on facility quality, non-linear results (results not steadily increasing with facility quality) indicate an “indirect impact.” However, highest tier consistently shows best results indicating necessity of school facilities in top condition to realize substantial gains.


- Summary of research connecting facility conditions to learning outcomes, includes bibliography
- Relevant Studies: outlines general conclusions and evidence pertaining to building quality & maintenance, visual comfort, thermal comfort, acoustics, indoor air quality, effects on teachers


- Report studying relationship between Los Angeles Unified School District (LAUSD) compliance with healthy and safety regulations and academic performance
- Health & Safety Compliance: looked at accident prevention, asbestos, fire & life safety, campus security, chemical safety, pest management, lead management, restroom facilities, indoor air quality, maintenance and repair, safe school plan, emergency preparedness, traffic and pedestrian safety, science lab safety.
- Overall Compliance Rating: Results summarized into OCRs, low OCRs typically (but not always) indicated a school in poor condition due to age, overcrowding, deferred maintenance or poor initial design
- Academic Performance Index: controlled for student body size, school size and grade level, compliance rating found to be linked with API, academic achievement measured by standardized testing
- 36 Points: Improving worst OCR school to the best suggest 36-point jump, on average, in API


- Report summarizing which facility attributes affect academic outcomes the most, by manner and degree
- Research Categories: indoor air quality, ventilation, thermal comfort, lighting, acoustics, building age and quality, school size and class size
- School Facilities: improving school facilities through spatial configuration, air quality and acoustics does have an effect, and improvements are easily achieved with available technology. Age is amorphous
- Size: Small schools effects strongest on lower socioeconomic groups, class size unresolved by evidence but assumption of smaller is better has large impact on school planning (requires more classrooms)
- Prevailing Issues: cites need for better, more standardized facilities definitions and rigorous research about subject—too much anecdotal or case-based.

- Report studying relationship between Houston Independent School District (HISD) inadequate infrastructure and student achievement
- Diverse Conditions: HISD study including diverse socioeconomic communities and included aged facilities as well as new facilities
- Research Factors: looked at temporary space used, need of roof repair, number of custodians and facility space per student and used data from test scores and school profiles
- Inadequate Infrastructure: evidence suggests that students at schools with roofs needing repair, that relied on temporary structures and/or had understaffed custodial services were less likely to attend school, more likely to drop out and less likely to meet a high level of scholastic achievements


- Report studying relationship of school facilities on student performance and teacher effectiveness
- Measurable Impact: schools with better design features, particularly acoustics and indoor air quality, have a measurable impact on student performance. Quality can have positive or negative impact.
- Building Age: Older school buildings typically have more trouble with thermal comfort and noise levels
- Positive Impact: students in better schools outperform those in substandard ones by several percentage points. Class size reduction also suggests higher achievement improvements
- Teacher Effectiveness: Measured through perception studies, teachers reported physical improvements enhancing the teaching environment. Overcrowding has a pronounced negative effect on perception.


- Article examining facilities factors and the ways they impact students’ ability to learn
- Old Schools: challenges of aging schools including inadequate learning environments and unsuitable conditions for equal learning opportunities—ADA and IAQ (asthmas)
- Noise: special acoustic needs and challenges for children, reviews the types of noise distractions and problems that arise in the classroom
- Relocatables: the issues created by portable classrooms through maintenance needs and location away from main school building
- Stronger Communities: Schools in better condition not only have higher achievement, but have stronger support from their communities


- Thesis synthesizing the research since 1980 on the impact of school facilities on student achievement and behavior
- 53 Studies: compiled studies looking at noise, facility age, color, lighting, maintenance, density, climate conditions and classroom structure.
- Direct Relation: Building condition lighting and site noise found to have conclusive effect on student achievement and behavior.
- Research-Based Design: Discusses Cash & Earthman’s studies to develop knowledge base for research-based school designs that enable the highest level of achievement possible
RESOURCES FOCUSING ON SUSTAINABILITY:


- Study investigating whether daylight and other indoor environmental factors impact student learning
- **Indoor Environment:** controlling for variables such as demographics, study analyzed test scores to compare effect of ventilation, indoor air quality, thermal comfort, acoustics, electric lighting, views, classroom type on student achievement
- **Window Effects:** while previous statistical findings were not replicated in study, window characteristics were found to have “as much explanatory power” to explain student performance as other educational metrics such as teacher characteristics or attendance rates


- Whitepaper providing an overview of green schools, including how high performance environments maintain healthier indoor environments and can support better student learning, health and productivity
- **High Performance Factors:** focuses on importance of indoor air quality and detrimental effect poor air quality created by VOCs, mold and ventilation can have on children, particularly those with asthmas and autism


- Study demonstrating the financial, environmental and educational ROI of green technology in schools
- **Cost Savings:** examines cost saved from reduced utility usage, maintenance needs and other O&M factors that can be reinvested into the classroom
- **Health Benefits:** Examines reduction of absenteeism (student and teacher), visual and auditory challenges and effect on learning, productivity and motivation
- **Financial Earnings:** Projects future financial earnings and success of students who have access to better learning environments, based on projected achievement rates gathered from several cited studies


- Paper examining benefits of building and investing in sustainable K-12 schools
- **Green Benefits:** Teacher retention, student health, long-term cost savings, curricular opportunities
- **Design Factors:** looks at impact of ventilation and indoor air quality, temperature and climate control, acoustics, lighting, building age, school size, classroom design and class size


- Report documenting the financial costs and benefits of green schools compared to conventional schools, with the intent of arguing the cost-effectiveness of the investment
- **30 Green Schools:** Includes national review of 30 green schools and available data outlining their cost
- **Green ROI:** Argues that while green schools do tend to cost 1.5-2.5% more than conventional schools, this investment is offset by 10-20x from long-run benefits (or a projected $60-70 for every $4 invested)
- **Sustainable Offsets:** suggests that sustainable school investments more than pay for themselves through energy and water savings, reduced costs from waste and emissions, increased student learning and earning power, reduced absenteeism, reduced teacher turnover and employment gains for the local economy