School Buildings: The Foundation for Student Health and Success

Improving the school building may well be the most overlooked means of improving student health, safety, and academic performance. Yet in conversations about factors that lead students to academic success, only rarely does the role of the physical environment come to the fore.

By downplaying the importance of the building, policymakers and parents alike may be missing one of the largest health and safety issues affecting students daily. For example, 13.8 million school days are missed each year due to childhood asthma.1 This cause of chronic absenteeism can only be reduced if education leaders target its leading cause—poor indoor environmental quality.

There are nearly 51 million K-12 students in the United States, and they each spend more than 15,600 hours in public schools by the time they graduate. Schools must make the most of this critical window for social, academic, and physical development. Children are not little adults: They breathe larger volumes of air relative to their body size, have larger pupils and faster metabolisms, experience more frequent hormonal changes, and are less able than adults to change their surrounding environmental conditions at will.

Environmental factors such as ventilation, thermal control, lighting, and noise have serious implications for student safety and academic achievement. Properly designed, maintained, and operated school buildings that address these environmental factors have been shown to prevent cognitive deficits, optimize student and teacher performance, and create a thriving learning environment within the school.

In 2017, The Healthy Buildings Team at Harvard T.H. Chan School of Public Health released the report “Schools for Health: Foundations for Student Success.”2 The report details findings from over 250 research articles unequivocally demonstrating how health is foundational to student thinking and performance, includes more than 70 health and performance metrics, and builds upon previous T.H. Chan School research, “9 Foundations of a Healthy Building.” The report synthesizes more than 30 years of research about the impacts of indoor environmental quality in schools, identifies diverse metrics of success beyond standardized test scores, and provides an accessible, evidence-based guide to the daily, acute, and chronic effects school buildings have on students and staff (see table 1). This article introduces key findings from this report that state boards of education may reference as they seek to promote healthy learning environments.

Effects of Environment on Performance

More than 20 studies show that school conditions such as indoor air quality, temperature, and acoustics have significant impacts on student standardized test performance. For example, in poorly ventilated classrooms, researchers observed a 5 percent decrement in students’ “power of attention,” roughly equivalent to the impact that a student might feel from skipping breakfast.3 However, numerous studies show that classrooms regularly exceed Acceptable Indoor Air Quality recommendations set by the American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE 62.1). It is not uncommon that peak concentrations of carbon dioxide reach 3,000 ppm, three times the ASHRAE limit.

A study in New York City showed students taking a standardized test on

Attention to the indoor environmental quality of schools pays off in student and staff health improvements.

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Table 1. Building Quality’s Effects on Student Outcomes

<table>
<thead>
<tr>
<th>9 Foundations</th>
<th>Student Health</th>
<th>Student Thinking</th>
<th>Student Performance</th>
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</thead>
<tbody>
<tr>
<td><strong>Ventilation:</strong> Low ventilation rates</td>
<td>▲ nasal patency ▲ communicable disease transmission ▲ asthma ▲ fatigue</td>
<td>▼ cognitive function ▼ attention span ▼ concentration ▼ focus</td>
<td></td>
</tr>
<tr>
<td><strong>Air Quality:</strong> High indoor carbon dioxide &amp; volatile organic compounds</td>
<td>▲ allergies ▲ asthma ▲ eye, throat &amp; nose irritation</td>
<td></td>
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| **Thermal Health:** High indoor classroom temperature | ▼ respiratory health ▼ self-reported comfort | ▼ memory ▼ response time ▼ concentration | ▼ test scores
| **Moisture:** Presence of indoor dampness and mold | ▲ headache ▲ dizziness ▼ respiratory health ▲ eye, throat & nose irritation ▲ fatigue | ▼ comprehension ▼ concentration | |
| **Noise:** High indoor and outdoor noise levels | ▲ stress & hormone response ▲ fatigue ▼ cardiovascular health | ▼ memory ▼ comprehension ▼ concentration ▼ hearing | |
| **Safety & Security:** High perceived threat to safety | ▲ stress & hormone response ▼ mental health ▼ physical activity ▼ sleep | ▲ self-report anxiety & stress | |
| **Lighting & Views:** Reduced glare & flicker; proper illuminance & color temperature | ▲ mental health ▼ physical activity ▲ vision | ▲ alertness ▲ concentration ▲ focus | ▼ test scores
| **Dusts & Pests:** Presence of cockroach allergen | ▼ sleep ▼ respiratory health ▲ asthma | | ▼ attendance
| **Water Quality:** Lead levels exceeding EPA standards | ▼ bone growth & development ▲ risk of anemia ▲ abdominal pain ▲ cramping ▲ high blood pressure ▲ nausea | ▲ irritability ▲ ADHD ▲ hearing loss ▲ behavioral problems ▼ attention span ▼ cognitive function | ▼ IQ
Teachers have the highest proportion of work-related asthma cases of the nonindustrial occupational groups. They commonly report headaches, allergies, fatigue, and throat strain while working in deteriorating or inadequately maintained buildings. Finding ways to improve their overall well-being can reduce costs for substitute teachers and improve teacher retention. Equally important, healthier teachers are better equipped to optimize student learning and success in the classroom.

Access to good indoor environmental quality in K-12 schools is an environmental justice issue. Nationally reported statistics show that decreasing quality of school buildings is associated with an increase in the percentage of nonwhite and reduced-price meal eligible student populations.6 Specifically, minority students and students eligible for free and reduced-price meals are exposed to lower ventilation rates and higher temperatures,7 attend schools without long-term, written facility plans, a 90 degree day versus a 72 degree day were 12.3 percent more likely to fail the exam, roughly equivalent to the black-white achievement gap. Yet current indoor temperature standards (ASHRAE 55) do not account for student metabolism, activity level, or subjective preferences, which may result in reductions in attention, performance in physical education, and standardized test scores.8 Additionally, comprehensive data about air conditioner use and quality do not exist across states.

Promoting student and teacher well-being begins with understanding the diverse physical environment impacts. The Healthy Buildings Team references nine foundational elements of a healthy building as a guiding framework to explore these associations (see figure 1).

**Health for All**

Poor school building quality also burdens teachers, staff, and the most vulnerable learners.
or have fair or poorly rated outdoor facilities, playgrounds, or sidewalks.8

Evidence for Action

Ensuring healthy indoor environments is not just jargon but a strategy to help students reach their full learning potential. After implementing an indoor air quality (IAQ) management program based on the U.S. Environmental Protection Agency’s IAQ Tools for Schools checklist,9 the Omaha Public School District observed a decrease in the frequency and severity of asthma attacks.10 In Connecticut, adoption of a program based on the checklist has helped address IAQ problems in more than 850 schools. Research shows that students in classrooms that received portable mechanical ventilation system interventions performed faster and more accurately on computerized tasks.11

Much work remains. Just half of the approximately 98,000 K-12 schools in the United States have an IAQ management plan, 41 percent of school districts have not tested for lead in the drinking water,12 and approximately 25 percent of schools may still contain the probable carcinogen polychlorinated biphenyls (PCBs), a building material used in old caulk and light ballasts that has been associated with developmental and cognitive deficits, reproductive health risks, and liver damage.13

Benefits Outweigh the Costs

One perceived barrier to addressing these problems is cost. Yet new technologies and innovations can result in both energy reduction and indoor quality improvements. For example, in California, the estimated benefits of increasing the ventilation rate in K-12 classrooms were 30 times greater than the estimated energy costs, which doesn’t include the savings associated with lower healthcare costs and sick leave for teachers and staff.14

School infrastructure investment may seem costly, but the economic impact of inaction is far greater. Chronic exposure to early adverse poor environmental conditions for children translates into productivity loss, reduced employment earnings, and reduced quality of life later in life.15 After recognizing the return on investment, coordinating local and state political efforts, and three years of relentless advocacy, the State of Rhode Island had $1 billion on their November 2018 ballot dedicated to school infrastructure improvements. Their efforts exemplify a statewide commitment to healthy, high-performing schools. Research suggests their investment in school building infrastructure will improve more than aesthetics and result in real gains in student performance.16

Next Steps

State boards of education across the country should advocate for healthy, high-performing school buildings. Sharing the “Schools for Health” report with constituents is a useful first step toward launching a discussion of the role school buildings play. State boards should embrace their convening power to engage teachers, students, and staff in a practical discussion about their experience within their schools. These efforts can illuminate best practices and key challenges for good environmental quality as well as suggesting financial and policy priorities for school boards. With the evidence report at hand, state boards can advocate for policies to ensure schools’ indoor environmental quality is assessed routinely and for districts to consistently allocate resources for equitable repair, renovation, and new construction of K-12 facilities. As in Rhode Island, awareness about these relationships can lead to grassroots advocacy for investment and policy change.

By measuring school indoor environmental conditions qualitatively and quantitatively across the state, state efforts and resources can be tailored to communities’ needs. School boards have a unique opportunity to make lasting change, whether it is adopting statewide policies for green cleaning or engaging with local experts. One thing is certain, school buildings influence students’ health and academic performance. Improving school environmental quality will promote healthier teachers, more equitable education opportunities, and safer and smarter students.1

3David A. Coley et al., “The Effect of Low Ventilation Rates...
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14 Durlak et al., “The Impact of Enhancing Students’ Social and Emotional Learning.”


16 Ibid.; Durlak et al., “Meta-Analysis of School-Based Universal Interventions.”


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15 Haverinen-Shaughnessy and Shaughnessy, “Classroom Ventilation Rate and Temperature.”

16 Alexander, “Condition of America’s Public School Facilities.”


24 Bakó-Biró et al., “Ventilation Rates in Schools.”