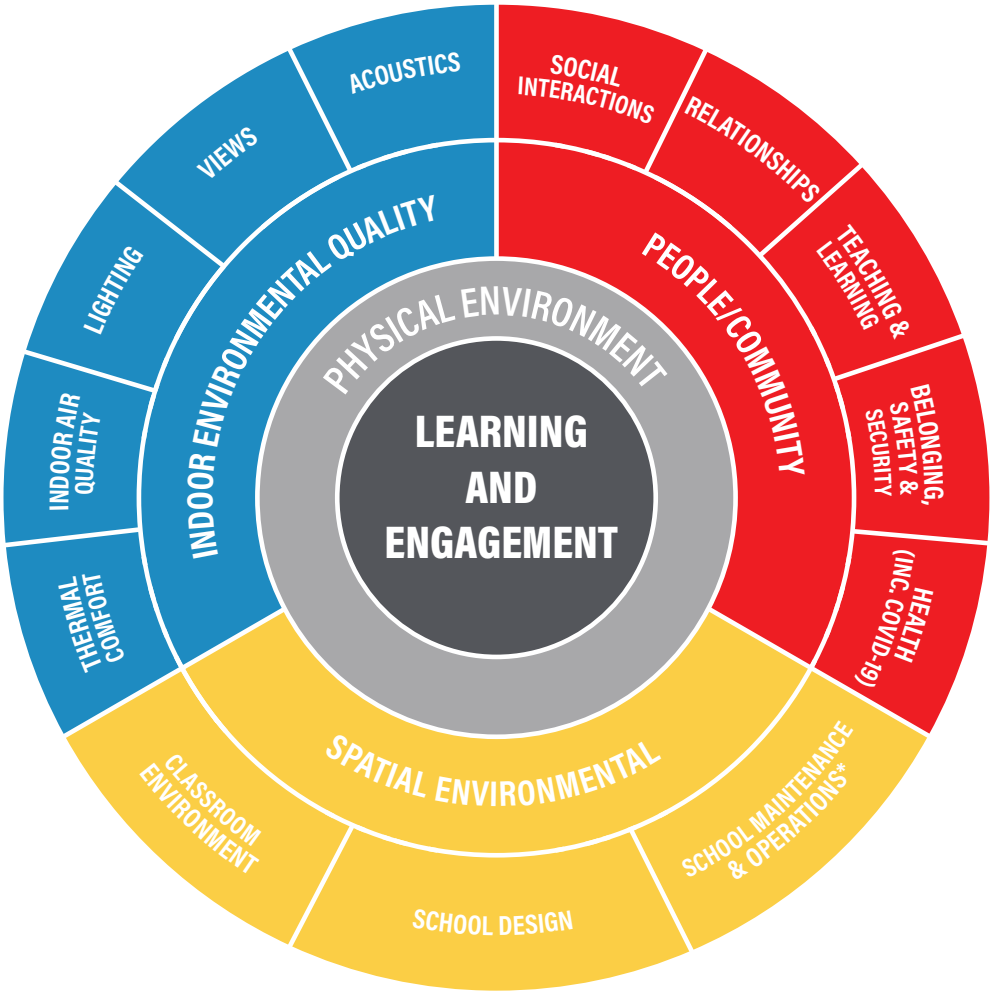
The Impact of School Facilities on Student Engagement and Learning



This project outlines, catalogs, and summarizes a framework of literature that highlights the impact of school of facilities and classroom environments on student engagement and learning. The NetZED Laboratory at the University of Oregon commenced this project following a Request for Proposals from the California School Facilities Research Initiative (CSFRI) which sought to identify elements of the built environment of K–12 schools that result in higher levels of student engagement and learning. CSFRI's goal was to summarize existing literature regarding the effects that physical organizational environments and furnishings within classrooms, makerspaces, laboratories, and interior ancillary facilities, as well as space at the exterior of the building that contribute to

See attributions and references in the paper "The Impact of School Facilities on Student Learning and Engagement".

student engagement and learning. The overall intent of this project is to draw upon published evidence and original research to support the design planning and process for facility planners/managers, architects, educator, and community members who will seek funding to renovate and build new schools in California.

With learning and engagement at the center, we developed a diagram of relationships of the school's physical environment that includes three categories: indoor environment, spatial environment, and the people/community in relation to the school and classrooms.

The review initially captured more than 750 peer-reviewed papers, reports, dissertations, books and literature reviews using framework, key word searches, and relevancy criteria, and stored through shared referencing software (Mendeley). Approximately 500 publications were selected to become an annotated bibliography and form the basis for this white paper. The review included studies from around the world, though most studies are applicable to conditions in the U.S.

These info sheets present the key findings of the white paper developed for the project. The info sheets are organized by the three categories shown in the Framework, and examine the sub-categories as they impact learning engagement and performance:

Indoor Environmental Quality (IEQ)

Indoor Environmental Quality (IEQ) refers to all the factors that influence the occupants' sensory experience of a place and includes thermal comfort, indoor air quality (IAQ), lighting (daylighting and electric lighting), views, and acoustics.

Spatial Environment

Spatial Environment includes school design characteristics of the buildings and grounds, school operations and maintenance that influence the functioning and operations of building systems and surroundings, as well as the spatial design of classrooms and within classrooms such as furnishings and arrangements.

People and Community

People and Community includes social interactions, relationships, teaching/learning, belonging, safety and security, health and recent innovations and impacts of the design planning around the pandemic.

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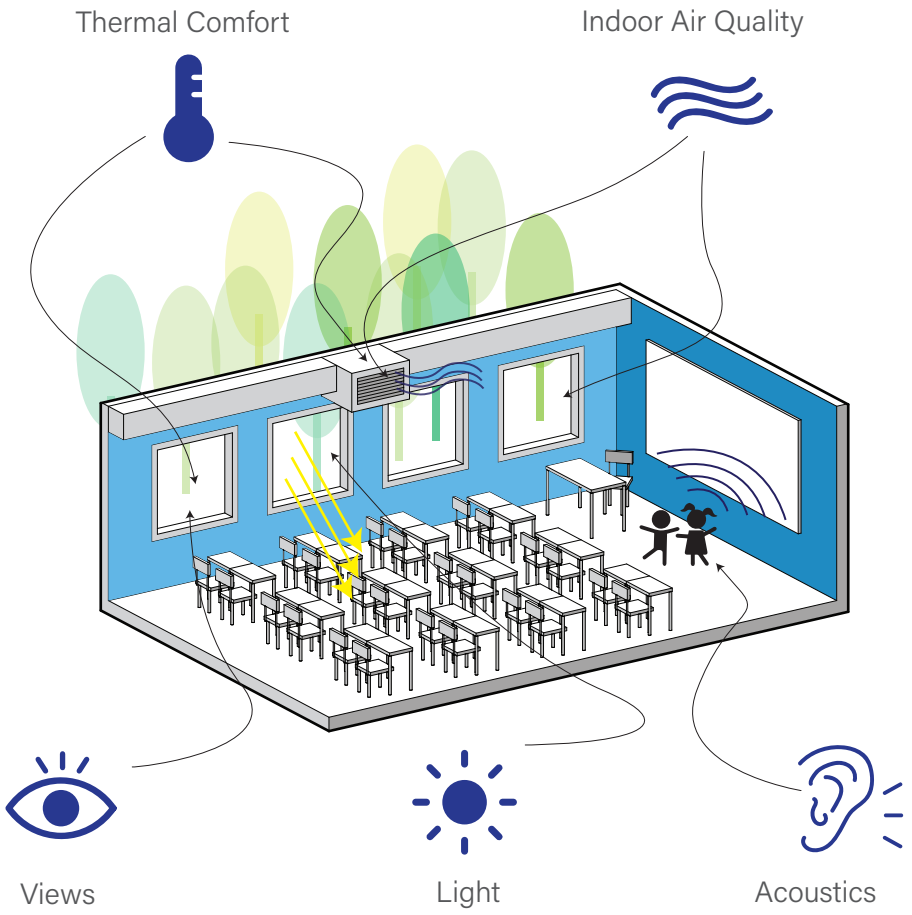
Indoor Environmental Quality (IEQ)

The indoor environmental quality (IEQ) category refers to factors of the school environment that influence the sensory experience of a place. This category includes subcategories: thermal comfort, indoor air quality (IAQ), lighting (daylighting and electric lighting), views, and acoustics.

Studies in this category often matches physical measurements of classrooms with qualitative surveys of perceptions, attitudes, and behaviors.



Key findings

Thermal comfort

There is consistent evidence that children prefer cooler temperatures than adults.

There is no consensus on which temperatures allow for better student performance.

Thermal distraction, discomfort, and physiological responses may decrease student performance.

Issues of adaptability, ventilation types, and temperature variations for performance need further study.

Wargocki & Wyon (2007) found that reducing the air temperature in classrooms from 77°F to 68°F (25°C to 20°C) significantly improved the performance of children schoolwork in numerical, language, concentration, and logical thinking tasks in terms of speed ($p < 0.05$).

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Indoor Air Quality (IAQ)

Increased ventilation rates increase student performance. Conversely, low ventilation rates hinder concentration and test performance.

Researchers have studied pollutants and microbes in schools concerning health, but few studies have linked them directly with student performance.

The relationship between IAQ, health, absenteeism, and performance needs further study.

Fisk (2017) found compelling evidence of an association of increased student performance with increased ventilation rates to as much as 15%.

Bakó-Biró et al. (2012) developed 16 interventions in classrooms changing ventilation rates from 1 L/s to 8 L/s. Students' performance increased in choice reaction (2.2%), color word vigilance (2.7%), Picture memory (8%), and word recognition (15%) with the intervention.

Views

Views of nature decrease stress and increase student performance.

A good view out of windows is significantly associated with better student learning.

Indoor plants have a positive impact on student attention and perceptions of the classroom and class.

Li, D., & Sullivan, W. C. (2016) found that when comparing classrooms with no windows, barren windows, and windows with views of vegetation, students' attentional capacity was 14.33% higher in windows with views of nature than the other two combined and had an increase in 13.12% in attentional functioning.

They found that stress reduction was 1.36 units higher in the window with a view, when compared to the barren condition, and there was no significant difference between the no window and barren conditions.

Lighting

Access to daylight and windows positively impacts student performance scores.

Higher lighting Color Correlated Temperature (CCT) appears to play a role in students' visual acuity and performance, but the wide variety of studies doesn't allow to reach a universal conclusion.

Lighting produces non-visual effects associated with mood and behavior.

Acoustics

Children are a high-risk group for chronic noise exposure.

Poor acoustics affect students' learning and communication.

High reverberation times and background noise decrease student performance.

Spatial Environment

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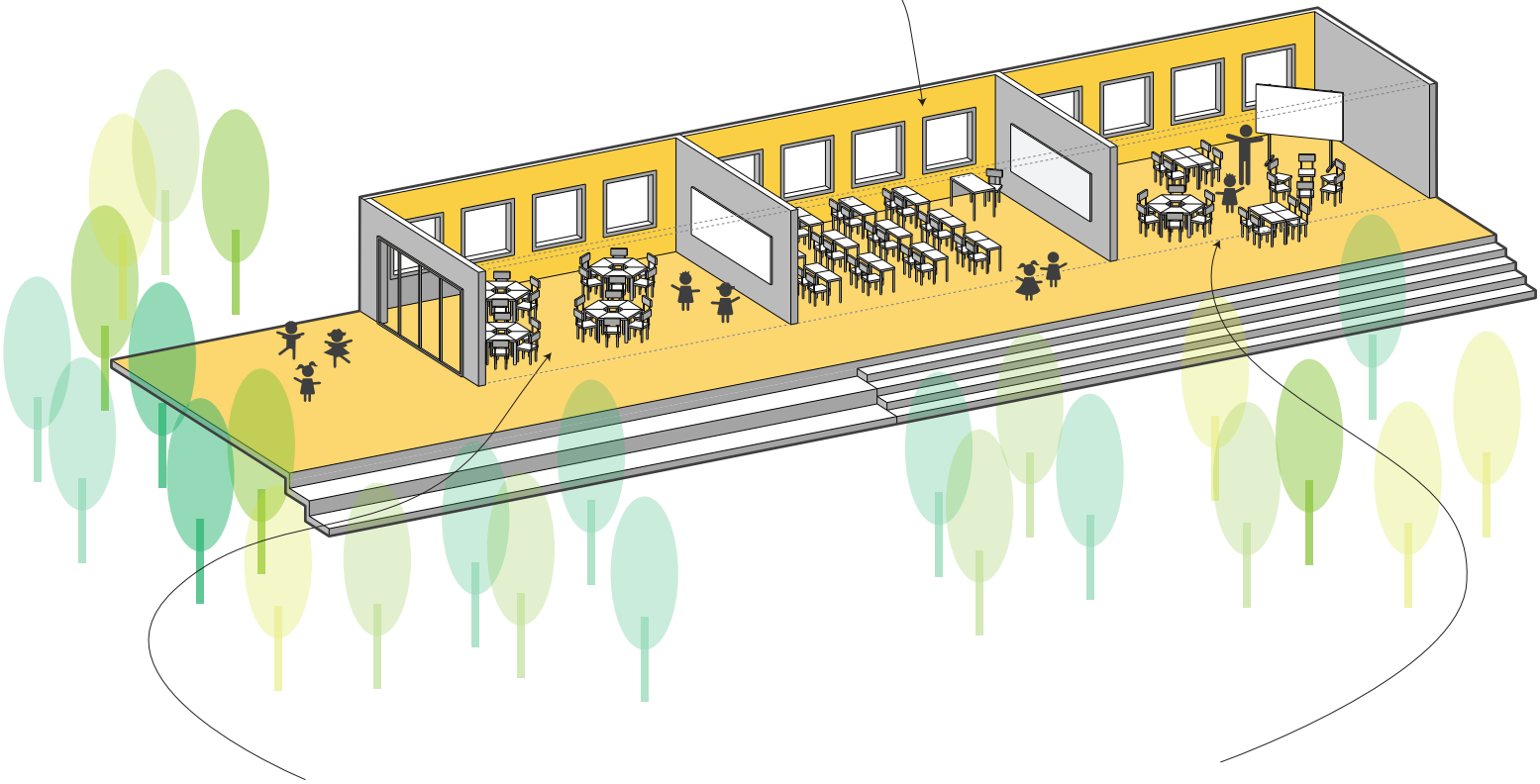
The spatial environment category includes school design characteristics both inside buildings and outside of the classrooms on the school grounds. This category includes subcategories: school design characteristics, school operations and maintenance that influence the functioning and operations of building systems and surroundings, and the classroom environment (e.g. furnishings, technology, flexible organization).

School Design Characteristics



School Maintenance & Operations

Classroom Environment

See attributions and references in the paper "The Impact of School Facilities on Student Learning and Engagement".

Key findings

School Design Characteristics

Schools' outdoor green space has a significant positive impact on health, learning and academic achievement.

Schools should be flexible and accommodate for a variety of learning situations and activities: social/private, noisy/quiet.

Less dense classrooms are related with increased student ownership and better student-teacher connection.

Kuo et al. (2019) found that nature-based learning increased interest in uninterested students, improved grades, reduced dropout rates, disruptive episodes, and helped to close income-related gaps. In group settings, nature allowed for less fidgeting for students with attention disorders, allowing for less distraction and a better learning environment. Low-performing students improved and increased their leadership skills in nature-based environments.

A qualitative case study by Dutt (2012) found that successful indoor/outdoor interfaces and plenty of play space in gardens and forests provided students with a great sense of joy, freedom, social cohesiveness, and aesthetic pleasure in relation to the built school environment.

A report from the Johns Hopkins School of Public Health (2021) concluded that ventilation investments can be cost-effective, and better than deep cleaning as a measure to prevent COVID-19. Investing in healthy air now can create benefits that outlast the pandemic.

Mendell et al. (2013) calculated that increasing Californias schools' average ventilation rates to the state standard, school absence would decrease by 3.4% in the state. This upgrades would cost $4 million, but they could increase annual attendance-linked funding by $33 million, making the upgrades cost effective.

School Maintenance & Operations

Ventilation investments are a necessary and long-lasting measure to prevent COVID-19 and support student performance and general health.

Building disrepair has been associated with student performance and absenteeism.

Green schools haven't been directly associated with increased student performance, but their enhanced IEQ, relation to nature and energy efficiency are beneficial for students.

Classroom Environment

Flexible learning spaces allow students to be less sedentary, enable improved student performance, but may present pedagogical challenges.

Classrooms that incorporate technology, such as Active Learning Classrooms may increase student engagement and performance.

Ergonomic furniture positively impacts student health.

People and Community

The people and community category includes teachers, students, staff, and the larger community of neighborhood where school facilities are situated. This category includes subcategories: social interactions at the scale of the community and neighborhood; relationships between teachers and students; teaching and learning in flexible spaces that can adapt to changing pedagogy and teaching needs; sense of belonging, safety and security to enhance pride, learning, achievement, and well-being; and health and long-term well-being and recent innovations and impacts of the design planning around the pandemic. Studies in this area are qualitative and relational where information is not commonly reported with specific numbers and quantifiable data.

Key findings

Social Interactions

The influence of the greater community around a school indirectly impacts the student due to the economic, social, and physical stressors on parents, teachers, and school staff.

Neighborhoods and built environment surrounding the school can create spaces for youth to participate in activities which have been shown to help develop social emotional health and encourage prosocial behavior.

Creating a sense of community with strong access to services helps children to engage in healthy behaviors

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Relationships

Teacher support (training, physical space, and supportive relationships) contributes to a better workplace and effective teaching.

The student-teacher relationship is key in supporting social-emotional learning, encouraging prosocial behaviors, and creating more engaged and motivated learning.

When students feel supported, have a sense of belonging, and have opportunities to engage in activities, they can have increased well-being as well as better completion and academic outcomes.

Belonging, Safety, and Security

Safety and security encompass the environmental and spatial visual cues from departure from the home, on the way to school and on school grounds and the physical building.

Students who feel a sense of ownership and belonging to the school and community have social and academic success as well as long term trajectories of individual well-being and contributions to society.

Familiarity with the physical layout and uses of school buildings encourages activity that contributes to the feeling of community and pride in the school, also yielding a sense of security during emergencies.

Many studies suggest that school belonging and academic achievement measured with longitudinal and cross-sectional samples have a significant positive relationship. It has also been shown that school belonging is associated with higher levels of academic engagement. (Allen, et al., 2017)

Research supports importance of symbols in the school and classroom. For example, women of color in science can signal a space of belonging for female students studying computer science. In addition, highlighting student achievements can influence student performance and aspirations by improving learning outcomes, increasing engagement, and reducing disruptive behavior. (Cheryan, et al. 2014)

Teaching & Learning

Teachers need flexible and adaptable teaching spaces to accommodate changing pedagogy, new cohorts, as well as enhancing creativity for learning experiences.

Physical space for positive interactions as well as visual promotion of activities, awards, and future aspirations contribute to school belonging and pride.

Engagement and motivation, social and emotional skills, and prosocial behavior which encourages learning is influenced by the relationship of people, physical space, and time.

Health and well-being

Buildings and grounds used within and outside of school hours contribute to student well-being, increased physical and mental health, positive relationships, and increased access to student services.

The number of students participating in high risk and unhealthy behaviors can be decreased by having monitored activities in and out of school hours.

The long-term health and educational trajectories of youth can be influenced by the school community and resources it provides.

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