

School Environment, Academic Performance, and Student Wellness

Investigating how social and built components of a school environment can optimize academic performance while protecting and enhancing students physical and mental wellbeing.

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Introduction

In the US, we often perceive students' intrinsic qualities, such as intelligence, perseverance, and dedication, to determine academic success. However, recent research reveals much of student success is tied to environmental and demographic factors (Hanafi & Noor, 2016). In addition to aiming to design environments conducive to academic performance, educators need to take students' mental health and wellbeing into account. Increasingly, students report being overwhelmed by academic loads, chronic stress, and lack of wellbeing (Clay, 2011). These findings elucidate the importance for educational entities to prioritize students' mental health as well as academic achievement when designing learning space, such as through alterations to the built environment.

Recent studies show that the school environment can have a dramatic effect on academic success and wellbeing (Determan et al., 2019). Design interventions in academic classrooms and study spaces can improve students' academic performance and mental health. Primarily, these interventions are drawn from principles of biophilic design and place-identity theory. Biophilic design is born out of biophilia, the idea that human beings are most comfortable and at ease in physical spaces that resemble the natural world (Angier & Wilson, 2020). Biophilic Design aims to create spaces that connect the inhabitant to the natural environment. Place-Identity theory is the idea that your identity forms in direct relationship to the built environment (Proshansky & Fabian, 1987). The present module examines built and social components of the school environment that promotes productivity, performance, and wellbeing and makes suggestions for design interventions to maximize student wellbeing and success in and out of the classroom.

Building Structure and Layout

Students' academic performance and wellbeing are associated with a building's aesthetic qualities, such as wall décor, classroom size, and structural qualities, such as temperature control and building acoustics. School quality is correlated with academic performance, as measured by standardized test scores (Eide & Showalter, 1998). As the building quality decreases, attendance issues and dropout rates increase (Branham, 2004). Both structural elements such as heating and ventilation, as well as aesthetic issues such as painting, and building maintenance, have a large impact on student success. The previous literature consistently shows that as a building's structural and aesthetic quality drops, so does student's learning, achievement, and attendance (Maxwell, 2016). Building conditions influence wellbeing and performance both directly and indirectly, such as through impacting development, social dynamics, and students' feelings of self-worth, belonging, ownership, and value. It is the influence buildings have on social dynamics and academic ability which makes them so powerful in improving student achievement and wellbeing.

Place-Identity Theory

The environments you grow up in, such as a school, have huge impacts on your development and identity. This idea is supported by the Place-Identity Theory, which theorizes that identity forms in relationship to the environment (Proshansky & Fabian, 1987). For example, if a student's building is delapidated, they might experience lower feelings of self-worth. From their early childhood onward, kids spend an immense amount of time in school. Hence, schools can have either positive or negative effects on students dependent upon the school's building condition. A recent study found that when a school building is run down, students felt undervalued by the community (Maxwell, 2016), stressed, and unsafe in school (Mijanovich, &

Weitzman, 2003). When a student feels undervalued, it can be difficult for them to value themselves or their education and decreases their sense of belonging and community within the school (Maxwell, 2016). When a student feels unsafe or chronically stressed, it can also increase drop-out rates, lower motivation, and increase mental health problems such as suicide or depression (Pascoe, Hetrick, & Parker, 2019). These feelings can be both damaging to mental health and academic performance. To avoid negative consequences, or better yet, enhance students wellbeing and performance, it is important to maintain proper building quality and design with the student's development in mind.

Classroom Aesthetics and Wall Decor

Exposure to Nature and Natural Settings

You might not need a scientist to tell you the beneficial effects of exposure to nature, but the research is certainly on your side. A range of literature, from experiments to field studies, supports the positive connection between exposure to nature and mental health, academic performance, and physical health. In a recent meta-analysis, numerous studies were found linking exposure to nature to multiple components of mental health; according to the studies, exposure to nature increased positive affect, happiness, wellbeing, positive social interactions, social cohesion, community engagement, and feelings of life and task manageability (Bratman, et al., 2019). In addition, to mental health, this meta-analysis found exposure to nature enhances academic ability such as through improved cognitive functioning, memory, attention, impulse inhibition, imagination, and creativity (Bratman, et al., 2019). Visuals of nature, in particular, alleviate stress, while improving all around emotional functioning, enriching concentration, and stimulating pleasure through the visual cortex (Ryan, Browning, Clancy, Andrews, &

Kallianpurkar, 2014). Besides its obvious health and academic benefits, exposure to nature is also pleasurable for any individual.

In addition to mental wellbeing and academic success, nature exposure has been found to improve physical health. In one hospital study comparing patients in rooms with and without views of nature, the researchers found patients with views of nature to recover significantly faster and better than patients without a view of nature (Ulrich, 1984) and another, more recent study, found nature images to decrease feelings of pain (Vincent, Battisto, Grimes, & Mccubbin, 2010). Nature's effect only continues to expand as it grows in biodiversity (Adjei & Agyei, 2014). Even the smallest glimpse at nature has drastic effects on our physical and mental health, as well as productivity and cognition (Edwards & Torcelli, 2002; Wells & Evans, 2003).

Therefore, access to nature is essential in both schools and workplaces as well as anyplace we spend a great deal of time or energy. Nature is an essential remedy and component of physical health.

Wall Decor and Paint Color

In addition to nature, superficial elements in classrooms have a big impact on academic success and mental wellbeing. First off, the room decor matters. Room complexity is important; a plain room might disengage kids whereas a complex room might function as a distraction (Barrett, Davies, Zhang, & Barrett, 2015). A room needs a balance of blank and engaged space. One might explore room color as an option; however, the effects of room color are highly variable and based upon a student's background, individual differences, and cultural context. Therefore, the safest colors to explore might be neutrals and earth tones. These colors return to biophilic design and offer the least number of distractions. A better way to engage wall space is through classroom displays of students' work.

Displays of Student Work and Sense of Ownership

Displaying student work can increase ownership and consequentially student responsibility and diligence. When a school, classroom, or workspace displays and acknowledges students' work, it can increase students feelings of space ownership, self-worth (Maxwell & Chmielewski, 2008), and feelings of identification with the school (Killeen, Evans, & Danko, 2003). The degree to which a room is identifiable or personable is a measure of ownership of a space. As students' feelings of ownership increase, so does the space's potential for helping students absorb, memorize, and recall information (Barrett, Davies, Zhang, & Barrett, 2015). An educator can increase students' ownership of the space by displaying their work or having them play an active role in the classroom layout and some decision-making processes. Ownership of a classroom parallels ownership of responsibility. As a student feels more in control of a space, they feel more responsible. Greater responsibility extends beyond the physical space and into their mindset. If a student feels more responsible, they will be more responsible, and feel more able to handle different assignments and challenges.

Social Identity Priming and Academic Performance

In addition to identity and ownership, classroom design can be used to combat stereotype threat, leveling the playing field for all students. Decreasing salience of a stereotype is essential to combating stereotype threat (Steele & Aronson, 1995). In one study, students were randomly assigned to give a speech in a virtual classroom with either a photograph of Bill Clinton, Hillary Clinton, German Chancellor Angela Merkel, or no photograph at all. When Bill Clinton's photograph or no photograph was displayed, men were reported to give longer and better speeches than women. However, when the room displayed a photograph of Hillary Clinton or Angela Merkel, there were no distinguishable gender differences in speeches duration or

quality (Latu, Mast, Lammers, & Bombari, 2013). Introducing imagery of positive female role models gave both men and women equal opportunity for academic success; the display of female role models did not lower male performance, but rather increased and equalized female performance. In a similar study, textbooks that contain pictures of women scientists rather than men scientists improved female students' comprehension of the material (Good, Woodzicka, & Wingfield, 2010). This implies how a school chooses to decorate their walls and study material impacts stereotype reduction, identity, and consequently, student achievement.

Just as school decor can help, it can also impair student functioning and self-worth through student tokenization. Tokenism is the idea that only superficial attempts are made at inclusion. For example, American Indian high school students viewing images of Pocahontas or the Cleveland Indians mascot expressed lower self-esteem, community worth, and feelings of achievement (Fryberg, Markus, Oyserman, & Stone, 2008). Even stereotypes viewed as positive, such as 'all Asians are good at math,' can be negative as they weaken the students ability to be seen as an individual (Siy & Cheryan, 2013). Instead, displaying and learning about a diverse display of role models for minority groups, such as Frederick Douglass, Rosa Parks, and Grace Hopper, can combat stereotype threat and avoid tokenism. Seeing historical figures and role models which students can identify with increases their feelings of belonging in different fields and subject matters, as well as their sense of belonging, capableness, and intelligence in the learning environment (Rosenthal, Levy, London, Lobel, & Bazile, 2013). The more capable a student feels when performing a given academic task, the more likely they are to feel prepared to handle the assignment. This also combats stress and allows the student to perform at their best (Uphill, Rossato, Swain, & O'Driscoll, 2019). If the educator avoids tokenism, classroom decor can help combat stereotype threat and improve students' wellbeing and academic performance.

Class Size and Structure

Accessibility

Classroom and building accessibility is key for physical and social inclusion of all students. Making a space more accessible, such as to students with physical, mental, or learning disabilities, can enhance their sense of belonging in the physical space (Bucholz & Sceffler, 2009). Physical inclusion can parallel social inclusion, which can enhance students wellbeing and academic success (Cheryan, Ziegler, Plaut, & Meltzoff, 2014). In addition, designing the learning environment to cater to all types of learners, visual, auditory, kinesthetic, or some combination thereof, as well as students with learning disabilities, is an essential component of accessibility. Even genuine efforts towards achieving accessibility tells students they are welcome and a valued part of the academic and social environment.

Class Size and Density

In addition to accessibility, class size and density are essential components of the classroom environment. Traditionally, students perform worse at larger schools whereas smaller schools are consistently seen to have fewer attendance and behavioral issues and better student attitudes, feelings of belonging and connectedness, and extracurricular involvement (Evans, 2006). As school density increases, so does social withdrawal (Loo, 1972), conflict, aggression, and psychological distress (Maxwell, 2003), and academic success (Lee & Loeb, 2000). In one study, greater crowding increased learned helplessness with schoolwork, which decreased motivation, persistence, and academic success (Evans & Stecker, 2004). The more crowded the school, the less students felt they were able to successfully complete their homework assignments. However, a school or group can also be too small. Students benefit from diversity of thought and backgrounds, and you need at least 4 people to facilitate engaged, collaborative,

conversations (Laughlin, Hatch, Silver, & Boh, 2006). A four yearlong study of schools in Tennessee, the STAR Project, found class size works best around 13 to 17 pupils per educator (Achilles et al., 2008). However, according to literature on group size and dynamics, groups within classes are best at around 4-5 students each. Capping a group at 4-5 students has been found to be the ideal number for enhanced group flow, decision making, and balanced group contributions (Fay, Garrod, & Carletta, 2000). Therefore, while the prior research does not examine classes under 13 students, the literature on group dynamics suggest ideal classes could range from 4-13 students. In general, the smaller the school and class, the better for academic performance and social wellbeing.

Structural Components:

Just as the decor, setup, and social components are important factors in students wellbeing and academic performance, structural components such as lighting, audio, thermal, air flow, air quality, and smell play essential parts in students wellbeing and academic success.

Lighting

Light, natural or artificial, has key effects on student's academic performance and wellbeing. The quality and color of lighting can have many effects, such as on eye strain and visual comfort (Bommel & Beld, 2004), performance and wellbeing (Juslen & Tenner, 2005), and mood and social relationships (Boyce, 2003). For example, lighting allows students to see their school assignment and classmates better, which can improve their social relationships and academic performance (Juslen & Tenner, 2005). While natural lighting is seen to be more universally beneficial, both natural and artificial lighting can be advantageous to the learning environment.

Natural Lighting

Natural lighting has many positive effects on student wellbeing and academic success. Students learn best in rooms that have the most natural light exposure possible while preventing glare. Glare can distract and obscure information on boards from students, decreasing academic performance (Juslen & Tenner, 2005). In general, students exposed to more natural light in classrooms are found to perform better than students exposed to less natural light (Edwards & Torcelli, 2002). However, schools with the greatest amount of daylight and windows, were reported to progress about 20% faster in math and reading (Nicklas & Bailey, 1997). In another study of Swedish elementary schools, students in rooms without windows performed significantly worse than students in rooms with windows. Rooms without windows can disrupt a student's diurnal patterns and lead to breaks in concentration (Evans, 2006). In addition to academic consequences, inadequate exposure to natural light can lead to headaches, faintness, and illness, as well as increased permeability of blood vessels, decreased white cell activity, and increased risk of infection (Edwards & Torcelli, 2002). Depriving students of natural light not only decreases their academic performance, but it also weakens students physically and mentally, increasing risk for infection. Exposure to natural light is essential for performance and wellbeing.

Artificial Lighting

While natural light is preferred, artificial light, when used correctly, can also be beneficial to student's academic performance and wellbeing. Indirect artificial lighting is better than direct; indirect lighting increases cognitive functioning while decreasing consequences from direct lighting (Barrett, Davies, Zhang, & Barrett, 2015). The type and timing of artificial lighting is equally as important; Fluorescent lighting has been found to have numerous negative effects such as physical discomfort, worsened task performance, and headaches (Morrow &

Kanakri, 2018). Different types of lighting also have various effects on the body. In general, LED or colored lighting has been found to enhance an individual's productivity, direct attention, and concentration (Morrow & Kanakri, 2018). In another study looking at blue-enriched white light (17000k) vs white light (4000K), blue light was found to improve alertness, mood, performance, focus, and eye comfort (Viola, James, Schlangen, & Dijk, 2008). However, excessive blue light; such as from electronic devices, can damage photoreceptors (Tosini, Ferguson, & Tsubota, 2016) and disrupt circadian rhythms (Motamedzadeh, Golmohammadi, Kazemi, & Heidarimoghadam, 2017), negatively impacting health and wellbeing. At the same time, reddish light has been found to be beneficial to regulating sleep patterns and diurnal rhythms (Zhao, Tian, Nie, Xu, & Liu, 2012). The research indicates blue light can help productivity and alertness, while red light can enhance sleep and wellbeing.

In review, natural light is the best choice for both wellbeing and performance. When natural light is not possible or needs to be enhanced, blue or white light is best for performance and red light is best for wellbeing. Fluorescent light is detrimental to both wellbeing and performance. Blue-enriched white lighting is best for enhancing productivity and concentration, but should be used in moderate amounts to avoid eye damage. The next best to blue lighting is indirect artificial white light with about 3000k-5000k. In addition, white or blue light should only be used in the early day to avoid disruption of circadian rhythms. At night, it is best to switch to red light, as it has the least dramatic, and sometimes beneficial, effects on sleep.

Auditory Stimulation and Noise Exposure

Auditory stimulation, through noise or ambient sounds, also has important consequences on mental health, creativity, and academic success. The auditory environment can be positive or negative for students wellbeing and academic performance. External disruptive sounds, such as

construction or airport noise, can have detrimental consequences to students, whereas exposure to ambient nature sounds, such as birds, wind, and water, can be beneficial to students.

External Noise

Excessive external noise is detrimental to students, particularly when chronic. Specific to the classroom, excessive noise can increase students' distress, blood pressure, aggression and decrease perseverance, memory and retention, and academic achievement (Cheryan, Ziegler, Plaut, & Meltzoff, 2014; Clark & Sörqvist, 2012). In some extreme cases, students will adapt to chronic noise exposure by ignoring and tuning out auditory stimuli (Evans, 2006). This can be dangerous for students as the filter is indiscriminate and can also cause children to filter out speech, which lowers their speech perception decreasing both social skills as well as memory and retention. Even teachers are affected by excessive noise in the classroom, as they report greater fatigue, shorter patience, and heightened annoyance with their students (Evans, 2006). Not only can external noise disrupt a class physically, but it can alter educator's attitudes as well as a student's behavior and ability to take in new information.

Ambient Nature Sounds

Just as noise can be negative, it can also have positive consequences for students wellbeing. Exposure to ambient nature sounds, such as birds, wind, and water is positive and can improve student's mental health, calmness, and creativity as well as physical wellbeing. In one study, patients exposed to nature sounds were found to heal 37% faster than those exposed to urban noise, such as traffic (Alvarsson, Wiens, & Nilsson, 2010). Ambient nature sounds can best increase creativity and performance when played between 50 and 85 decibels, normally at 70 decibels (Mehta, Zhu, & Cheema, 2012). Another study found heavy rain sounds to significantly increase students arithmetic speed and accuracy better than silence or classical

music (Proverbio, Benedetto, Ferrari, & Ferrarini, 2018). In addition to increasing performance, natural sounds can also decrease students' stress and help them calm down after a difficult academic experience (Alvarsson, Wiens, & Nilsson, 2010). While chronic noise exposure can be detrimental, purposeful natural sounds can increase student performance and wellbeing. While it is critical to limit excessive noise exposure, in moderation ambient nature sounds can still be beneficial for students.

Airflow, air quality, ambient temperature, and smell.

The airflow, air quality, ambient temperature, and smell all effect student achievement and mental health for both physical and psychological reasons. Numerous studies find exposure to low-quality air to be linked to decreased student attendance and teacher abilities (Cheryan, Ziegler, Plaut, & Meltzoff, 2014) as well as academic ability (Evans, 2006). However, just as negative effects arise from poor air quality, positive effects can arise from enhancing air quality. In one study, introducing air-cleaning technology improved air quality and consequentially reduced absenteeism in a day care (Rosén & Richardson, 1999). Cleaning the air reduced particulates and decreased the spread of infection. This makes students healthier and consequently able to perform better in school.

Psychologically, airflow and temperature can also have drastic effects through a lack of environmental variability. When a classroom environment lacks sensory stimulation, it can lead to boredom and anxiety. This, in addition to prolonged periods of concentration and attention can cause students to lose focus and mental acuity. However, exposure to natural environments or modifications to the built environment, can restore attention and improve performance. According to the Attention Restoration Theory (ART), direct attention, attention that requires effortful control, is finite but can be restored through momentarily switching to effortless

attention, attention that requires little to no effort (Basu, Duvall, & Kaplan, 2018). This switch frees up direct attention to take a moment to restore itself, and gives the mind space for reflection. We switch naturally to effortless attention when our bodies are probed by some form of variability in the natural environment, such as light breezes or thermal changes (Basu, Duvall, & Kaplan, 2018). Restoring direct attention can improve concentration, comfort, memory, and academic performance. However, one must be careful of false alleviations; activities such as viewing TV or browsing social media does not restore direct attention despite being coined activities you do to “relax.” While these activities are enjoyable, they still require a significant amount of mental bandwidth and attention, reducing their restorative capacities (Basu, Duvall, & Kaplan, 2018). By understanding what components of the natural environment restore attention, we can make man-made changes to the built environment to either incorporate greater exposure to nature and natural elements or recreate environmental variability in the synthetic environment.

In addition to air flow, temperature and scent have large impacts on academic ability and mood. On hot days, teachers ranked students as more lethargic and less diligent than on cooler days. In addition, heat can increase aggression and decrease patience, which weakens performance and social connections. Previous research suggests the best temperature range to learn in is between 68° and 74°f (Cheryan, Ziegler, Plaut, & Meltzoff, 2014). Scent is more difficult to pin down. Too much of a scent can cause some students to have an allergic reaction or can make it more challenging to concentrate. When used in moderation, scents such as rosemary, citrus, and peppermint can help to energize students and aromas such as lavender and chamomile can help relax students (2020). These scents are best when evoked through essential oils, fresh fruits, or herbs.

Conclusion:

The built environment has a drastic effect on our productivity, cognition, and mental health. How we arrange our schools, classrooms, and workspaces drastically changes how able we are to succeed. The following list summarizes the above information into a list of key insights and recommendations for creating the optimal at home or classroom workspace to facilitate faster and better work and protect students' mental and physical wellbeing.

Recommended Changes for the built environment:

1. Improve building quality
 - a. Ensure the building and classrooms are up to date and structurally sound.
 - b. Ensure the building and classrooms are aesthetically pleasing.
 - c. Fix any broken facilities, objects, or building elements such as bathrooms, desks, or windows.
 - d. Freshen up the building; For example, add new coats of paint and plant flowers.
 - e. Create access to a green space and/ or outdoor play area.
2. Increase exposure to nature, natural settings, and natural elements
 - a. Add plants to the workspace or classroom. Add potted, hanging, and window plants whenever possible; in particular, explore adding a trellis or a living green wall.
 - b. Rearrange furniture, such as desks and tables, to face outside.
 - c. If the school is urban, make the roof green or create a courtyard.
 - d. Schedule breaks to walk in a park or nearby greenspace.
 - e. Create an internal courtyard or an outside workspace
 - f. Hang up pictures of nature in the classroom or workspace.

- g. Add a mixture of plants to the classroom; increase biodiversity.
3. Wall Space
- a. Use neutral or natural wall paint tones.
 - b. Achieve a moderate amount of classroom wall complexity.
 - c. Display images of nature, students work, and pictures of positive role models such as Martin Luther King, Grace Hopper, and Malala in the classroom.
 - i. Offer wall décor in braille and large print.
 - d. Have students paint murals on the walls.
 - e. Give students a voice in classroom or school building layout and design.
 - f. Use natural, minimally processed materials such as wood and stone to create or add to the school environment.
4. Class Size and Layout
- a. Maximize Accessibility
 - i. Make all doors are easy and automatic to open.
 - ii. Add ramps and widen hallways.
 - iii. Make the front of the classroom clearly visible.
 - iv. Train educators and administrators on how to best teach and help students with mental of physical disabilities.
 - b. Minimize class size to between 5 and 13 students and 4-5 students for group discussions.
 - c. Give students some degree of control over their learning environment.
 - i. Have students help to arrange the classroom layout and décor.
 - d. Lighting

- i. Maximize natural lighting, first and foremost, with expanded and additional windows and sky lights.
 - ii. Use blue or LED lighting to enhance work and productivity
 - iii. Use red light to creating calming and soothing spaces
- e. Auditory and Noise
- i. Improve acoustics through acoustic tiling in the classroom
 - ii. Decrease exposure to outside noise pollution, such as from a highway, train, or airplane.
 - 1. Sound-proof the school.
 - 2. Build the school in a quiet area and perform construction over the summer.
 - iii. Increase exposure to natural, ambient sounds.
 - 1. Heavy rain and water sounds are particularly beneficial.
 - 2. Set the audio range for about 70 or between 50 and 85 decibels.
- f. Enhance Air Quality, Air Flow, Ambient Temperature and Scent
- i. Plants help to improve air quality, naturally.
 - ii. Install air cleaning technology.
 - iii. Put screens in windows and open weather permitting.
 - iv. Build the school in an area with little air pollution.
 - v. Increase Environmental Variability
 - 1. Create different random moments of breeze or thermal changes.
 - vi. Keep the temperature between 68 and 74°f

- vii. Use rosemary, citrus, and peppermint scents to energize students and lavender and chamomile aromas to calm students

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