The Impact of Biophilia in Elementary Schools: A Study of Student Health and Well-Being

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Abstract

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Department of Architecture

This design research thesis explores questions in design methodology, provides insights on how to conduct design research, and ultimately serves to ignite a productive conversation between designers, teachers, administrators, and school stakeholders.

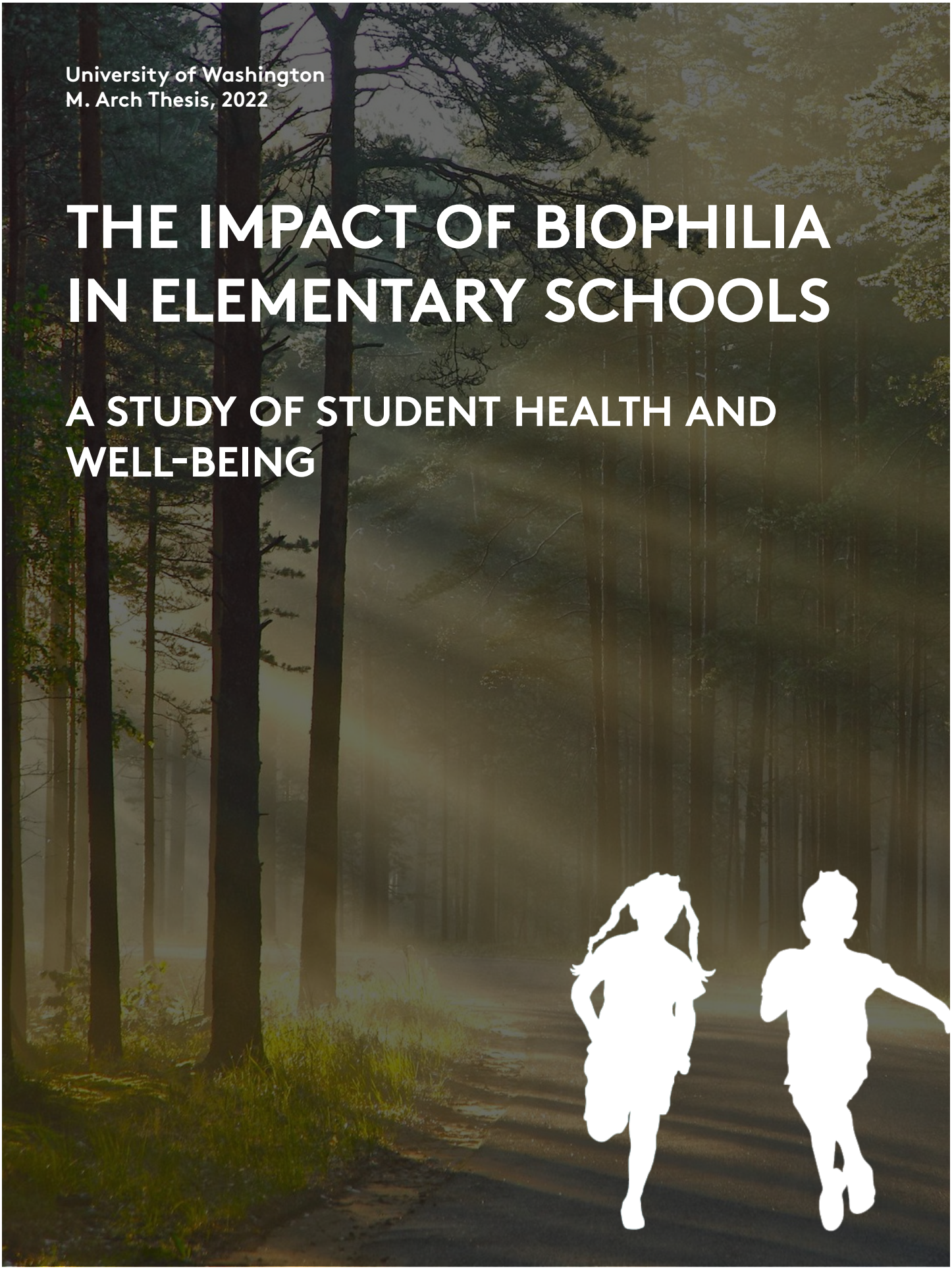
This thesis will make the claim that all elementary schools must use design strategies informed by concepts in biophilia to intentionally address the health and wellbeing of students as well as learning outcomes. This thesis will begin by exploring secondary sources related to the impact of biophilic design on student physical and mental health and wellbeing to identify areas of design, such as lights, daylight, materials, and ventilation, that significantly impact students. Future research should explore the difference in architecture in low-income elementary schools to understand the role of justice, equity, diversity, and inclusion. This thesis will examine and uncover the importance of including the principles of biophilia in design guidelines for elementary schools.

Future research might examine how biophilic design in schools can advance improved learning outcomes related to specific STEAM and Art curriculum.

University of Washington
M. Arch Thesis, 2022

THE IMPACT OF BIOPHILIA IN ELEMENTARY SCHOOLS

A STUDY OF STUDENT HEALTH AND WELL-BEING



Abstract

This thesis will make the claim that all elementary schools must use design strategies informed by concepts in biophilia to intentionally address the health and wellbeing of students as well as learning outcomes. This thesis will begin by exploring secondary sources related to the impact of biophilic design on student physical and mental health and wellbeing to identify areas of design, such as lights, daylight, materials, and ventilation, that significantly impact students. Future research should explore the difference in architecture in low-income elementary schools to understand the role of justice, equity, diversity, and inclusion. This thesis will examine and uncover the importance of including the principles of biophilia in design guidelines for elementary schools.

Issue/Problem Statement

The physical built environment does not adequately address the health, wellbeing, and learning outcomes of students.

Rationale/Claim

Elementary schools must utilize the ideas of biophilia, informed by place-based design, to support the health and wellbeing of students.

Thesis statement

Elementary schools are not adequately considering the impact of the physical built environment on students. This may be due to factors such as school district design standards (or the lack thereof), design professionals' experience/knowledge, budget considerations, as well as socioeconomic status. Regardless of these factors, all schools can successfully utilize the concepts of biophilia to support and positively impact student mental health, physical health, academic success, and social life.

How to Use this Thesis

A core goal of this research is to share the findings widely and legibly for those involved in the design of schools, including educators, administrators, and facility directors. Designers and architects will also be able to use this research as a guide when designing elementary schools.

The first section of this thesis explains why biophilic design in elementary schools is important. The second section includes design patterns that can be implemented. The last section explains common factors in school design and looks at Washington guidelines to understand how biophilia is incorporated and can be further implemented.

This thesis is best viewed online as two page spreads.

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NATIONAL BOTANIC GARD

RESEARCH FRAMEWORK

Introduction

Overview

This thesis will explore how considering biophilia in elementary school positively impacts student wellbeing and learning outcomes. The main research that will guide the thesis is based on existing theories and findings surrounding the intersection of biophilia in design and student wellbeing.

There are several key theories and ideas that are important to understand when exploring biophilic design.

Attention Restoration Theory

Attention Restoration Theory (ART) suggests that exposure to nature allows the brain to concentrate or refocus, especially after mental fatigue (Heather 305). There is a limit to how long the brain can focus on a specific task before experiencing mental fatigue. ART is one theory that connects time in nature to academic success as students often focus on tasks in the classroom for extended periods of time.

Nature-Deficit Disorder

This term was coined by Richard Louv to describe the consequences of humans being removed from nature as the world becomes more urbanized.

It is clear in existing theories that there is a correlation between human wellbeing and exposure to nature. This thesis will use these claims to support the call for biophilia based design guidelines in all elementary schools. Furthermore, it will propose place-specific guidelines to set an example for how other states might adopt biophilic design strategies in a sustainable and achievable way.

Methodology

Secondary sources, including existing literature and precedents regarding biophilia, as well as scientific studies about the health impacts of biophilia, will be utilized. A survey about biophilic patterns will also be distributed to teachers.

Scope of Investigation

This thesis will focus on students in grades Kindergarten through Grade 3, ages 5 through 9, in the United States public school system. Future research should extend to include preschool, middle, and high school students.

While the thesis may reference precedents outside of the US, the secondary research that the thesis is based on will be limited to sources that focus on the US public education system. The outcome of the thesis will focus on Washington public elementary schools.

Major elements that go into school design (see page 14) will also be cataloged and organized into 3 categories: stakeholders, design, influences. The stakeholders are the people involved with decision making and or impacted by school design. The design includes a list of the 6 top recurring design considerations found throughout the research. And then lastly, influences looks at anything that might impact what the stakeholders want or the design decisions made. This matrix will be utilized in the last section of the thesis in order to analyze next steps and applications of the research.

The goal of this thesis is to add biophilia as another major design consideration.

Even though biophilic design would impact more than just the students, students were the focus of the thesis.

STAKEHOLDERS	DESIGN	INFLUENCES
Students	Individualization/ Flexibility	Budget
Teachers	Safety/Security	Timeline
Administrators	School Size	Building Code
Staff	Physical Environment	Standards
Facilities	Common/Shared space	Regulations
Community	Technology	Guidelines
	Biophilia	

Major elements of school design.

Biophilia and Children

Nature plays a significant role in students' learning ability and health. Before exploring the impact of nature on elementary students directly, it is helpful to understand how the outdoors generally impact mental health. Ed Decker explores this topic in his article "How the Great Outdoors Improves Mental Health." Studies have shown that people who are more connected to nature tend to be happier overall. The term 'biophilia' was coined by E. O Wilson to label the attraction that humans feel towards living things. While in the past, a connection with nature was related closely to survival, nowadays the connection is more about pleasure and enjoyment. Though humans may look to nature first for enjoyment, the positive mental and wellbeing impacts that stem from time in nature cannot be overlooked. Some of the major benefits from time spent in nature include boosted mood, reduced stress, and increased resilience. Additionally, time in nature is very restorative and grounding. It provides a break from the hustle of daily life and allows for peaceful contemplation – a practice which has been shown to reduce impulsive decision making and anxiety (Decker).

Attention Restoration Theory

Ming Kuo explores the impact of nature on children's learning ability and mental wellbeing in "Do Experiences with Nature Promote Learning? Converging Evidence of a Cause and Effect Relationship". Kuo argues that students are better able to learn when they are less stressed, more attentive, more self-disciplined, and more engaged – all of which are qualities that can be increased from time in nature (Kuo 2). Each of these factors is specifically explored in the work to fully convey this correlation. Beginning with stress levels, Kuo explains that nature has been shown to reduce stress levels in children, proven through self-reported data and physiological measures. In terms of engagement and attention, teachers report that students who are either learning in nature or connected to nature in the classroom are better able to focus on the course and seem to be intrinsically motivated to do so, possibly due to nature's restorative qualities. Lastly, Kuo explores the self-discipline that students develop through time in nature, especially in regards to students with ADHD. Kuo uses the positive psychological benefits of nature to make a compelling argument for why nature must be considered in the design of schools.

Nature Deficit Disorder

In his article "Do Our Kids have Nature Deficit Disorder?" Richard Louv also looks at the impact of nature and argues that access to nature is important for children's ability to learn and their mental health. He argues that the gap between children and nature results in health and wellbeing complications, a phenomenon he calls the "nature-deficit disorder". To support this claim he cites various studies in which students who studied outside experienced significant improvements in their learning and behavior, pointing to the mental benefits of connecting students to nature. One study that Louv cites is from the American Institutes for Research in which students involved in outdoor science programs improved their test results by 27%. Also important to note is that students in elementary school showed a reduction in attention deficit/hyperactivity symptoms when they were engaged with nature.

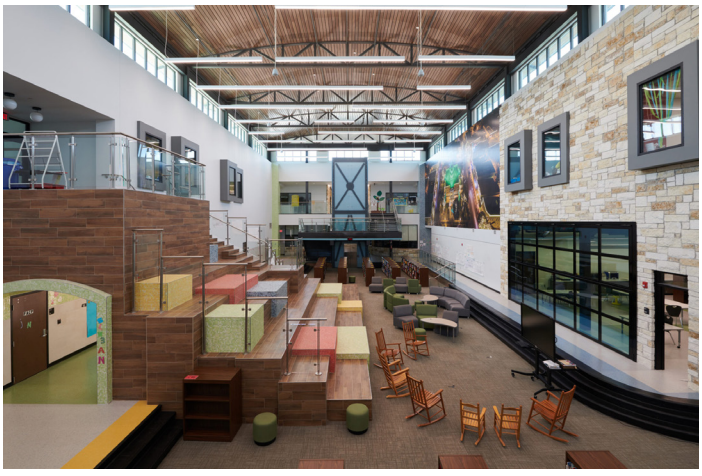
After making his claim that students should be exposed to nature more significantly in schools, Louv turns to examine a troubling trend in schools. In the 1970s, the design of schools became more inward focused. Many schools began to focus on the enclosed classroom, windowless hallways, and generally enclosed structure. Louv argues that we must move away from this trend as nature is the preferred classroom.

Louv concludes his work with a call for action through the proposal of several strategies that will increase student connection with nature. Some of his ideas include bringing nature into the classroom and green shared spaces in schools. While his ideas are open ended, Louv makes a compelling argument for why schools must integrate nature in order to support the wellbeing of children.

Ed Decker also explores the impact of nature, focusing on how access to nature impacts students' ability to learn in his article "How Time in Nature Boosts Learning in the Classroom". He focuses on daylight and how natural daylight positively impacts students' ability to learn math and reading. In one study, students in a school district with the sunniest classroom improved 26% faster in reading and 20% in math than students with less daylight (Decker). This makes a strong case for why students need access to natural daylight in order to most effectively learn.

There are many strong examples of schools that incorporate nature heavily into their design. The Annie Purl Elementary school is one such example as it features outdoor classrooms. These classrooms are flexible spaces that can incorporate a variety of activities and lessons, all while providing children with a direct connection to nature and positive learning environment.

The information in this section points towards the need for nature to be incorporated into elementary school design. Though it may be tempting to fully transition all elementary schools to outdoor programs, this is not feasible in many cases and not necessary. Rather, it is significant that students have access to nature, whether through large windows that look out to vegetation, courtyards, or green spaces in/ around the school.



Annie Purl Elementary school in Georgetown, Texas.

The Impact of School Design

Overview

The majority of the built environment is designed for adults and explored in relation to the experience of adults. Though this is the case, it is important to recognize that the built environment significantly impacts children's mental and psychological well being. The physical buildings in which they spend their time shape their perception of the world, affect their mental health, contribute to their development, and impact their ability to learn. Given this, and the amount of time that children spend in schools, it is important to explore the impact of the architecture of schools. While this impact can be understood from the perspective of designers, children, and health officials, this research will mainly focus on the perspective of designers and social science researchers. The scope of this thesis will also be limited to elementary age children and the specific impact of elementary school design on children. The goal is to explore several design considerations, including individualization, security, and nature, to understand how elementary school design affects the mental and psychological health of children. It also sets the stage for future research and encourages architects, designers, and city planners to rethink the design of schools to better promote the health and wellbeing of children.

While it should be acknowledged that school design impacts the physical health of students, the scope of this thesis will be limited to the impacts on mental and psychological health and wellbeing. This includes factors such as mood, self-esteem, focus, identity, appropriate development, ability to learn, and academic success. Several major design considerations will be explored, including individualization, security, and nature. This is not an exhaustive exploration of the design considerations that directly impact student health – rather it is a close examination of some of the main considerations that have been researched and heavily documented.

This thesis will focus on students in grades Kindergarten through Grade 5, ages 5 through 11, in the United States public school system. Future research should extend to include preschool, middle, and high school children. For the scope of this thesis, elementary students will be focused on as they are in a similar developmental stage and educated in the same building. While this research may greatly apply to these other groups of children, the mental and psychological impacts of school design on elementary students only will be explored. Psychological studies, health documents, architectural reports, and specific design examples will be used to understand the impact of architecture on children.

The goal of this research is to make a claim for why school design is significant to the mental health and psychological wellbeing of students. It will also provide ideas for future research, calls to action, and points of departure for the future of elementary school design.

Architecture & Well Being

Before exploring the impact of elementary school design on children, it is useful to have a general understanding of how architecture impacts psychological wellbeing and the current state of this research. While many different building typologies have been explored in terms of their relationship to design and mental health, the typology that is recurrent across this field of research is that of a psychiatric facility or mental hospital. Through the exploration and close analysis of the design of a space whose function is to improve the psychological wellbeing of its occupants, many conclusions can be drawn about the overall impact of architecture on mental health.

Edmund Ramsden explores this idea in "Designing for Mental Health: Psychiatry, Psychology, and the Architectural Study Project." His paper explores "the contribution of the mental hospital, as both laboratory and field site, to the development of the new field of environmental psychology which attended to the function and design of a range of city spaces to prevent mental illness and promote mental health in a period of urban crisis." (Ramsden 234). In this statement, Ramsden begins by

clearly stating the contributions that studying the design of the mental hospital has made to creating a movement centered around the intersection of mental health and architecture. This research made it so that mental health would be considered in various city spaces, buildings, and designs in order to understand how physical forms can prevent mental illness or improve it. To convey the applicability of this research, he states "The understanding of territorial behavior and personal space that had been established on the psychiatric ward (and which had been informed by the zoo) could be applied to the general hospital, prison, classroom, dormitory and even family apartment." (Ramsden 233). It is important to note that the applicability of the mental hospital to other spaces proves that research conducted in this paper around the school typology will be applicable to many other typologies and should not be thought of as one dimensional or linear.

In addition to understanding the conception of this field of research, it is also beneficial to highlight some of the general considerations that exist when designing architecture for mental health. Oftentimes, designers consider color, material, organization/layout, daylight, air, and nature as elements that directly impact how a person feels in a space and their state of mind. The following research will examine some of the main design considerations and factors that impact elementary students.

To understand the impact of elementary school design on children, it is imperative to have a general understanding of the influence attending school has on the average child's life between the ages of 5 through 11. According to the National Center on Education and the Economy, a typical student in the United States is required to attend school 180 days per year, on average for 6.8 hours per day. This does not include time spent in before/after school programs, clubs, and extracurricular events. Other than the home, the school holds the most consistent presence in the lives of elementary students.

In addition to the sheer amount of time spent in school, the psychological and mental development that elementary students experience during these years of their lives cause schools to hold even greater significance. At school, many young students refine their fine motor skills and coordination (School-age). As students progress through elementary school they learn to focus on tasks for greater periods of time – a skill that is important both at school and at home. Children also develop important coping strategies during elementary school. Stressors, such as bullying, workload, and learning disabilities are common during elementary school. Children must learn the proper skills to cope with such stressors since they can lead to anxiety and depression if left unaddressed.

Children must be allowed the space to develop these skills and behaviors properly, in a safe environment. At this age, children are highly active and often experiment. While this activity is crucial to their development, they must be supervised in a space that is safe and hazard free. Ample room for physical activity should be provided so that students can have the space they need to develop properly.

The formative development that occurs during elementary school is dependent on multiple factors, including class structure, curriculum, social relationships, and the individual capacities of each child. While these factors are significant and cannot be removed completely when studying the mental and physical wellbeing of children, this report will focus on how the physical school impacts children's development and mental wellbeing.

DEMOGRAPHIC

Overview

This research focuses on children in kindergarten, first, second, and third grade between the ages of five to nine. This group is at a crucial stage in their development, particularly in relation to how they learn and experience school. In order to understand how the design of their classroom impacts their wellbeing and academic achievement, it is first important to explore what is typically expected of children at this age developmentally, from social, physical, and cognitive lenses.

Developmental Milestones

Ages 5 through 8 may be referred to as "middle childhood". During this stage, children become far more curious about the world around them and their role in it. They begin to develop a sense of consciousness or consideration of what is right and wrong.

They are generally more social beings, interested in friendships, and able to practice sharing. Play is still central to their development and remains imaginative, though at this age children can distinguish between real and make believe. Their play becomes more elaborate and intricate with children assigning each other defined roles.

At this age learning adversities and difficulties start to become more prevalent. Emotional regulation also begins to emerge as an issue for many children as they learn to process big feelings. K-3 classes introduce increased social and learning expectations, as children are expected to have mastered certain fine motor and foundational skills. Given these expectations, students who experience delays in certain areas may feel frustration or anger when unable to complete certain tasks, fulfill expectations, or match their peers' progress.

An increased capacity for complex imagination benefits play, but also may have adverse effects on children as they are able to imagine traumatic scenarios, such as loss of a loved one. Children begin to understand loss and permanence. Events at home will also impact a child and at this age it is likely that they will process trauma through anger, oppositional behavior, increased fearfulness, and somatic symptoms. Fears of separation from a caregiver may also cause children to need increased reassurance. Due to this fear or other traumatic events, teachers may notice that students have difficulty focusing or concentrating as they revert back to earlier behaviors in order to cope.

Developmental Assets

The following assets are adapted from the Search Institute's building blocks for healthy development for children between the ages of five to nine. These assets are thought to help children become responsible, healthy, and caring adults.

The assets are divided into two categories: External assets which depend on the people surrounding a child, and internal assets which a child develops from within.

Considering the amount of time a child spends at school, it is imperative that these assets be present in a school environment.

Assets with a check mark are those that can be supported through biophilic design. This may be accomplished by:

- Exemplifying sustainable building methods which fosters a sense of environmental responsibility.
- Supporting self-regulation through the positive emotional impacts of biophilic design.
- Providing a sense of purpose through environmental stewardship.
- Allowing students to bond to the school through warm and comforting materials that reflect local ecology.

Providing opportunity for play and investigation through continuous contact with nature is essential for promoting healthy development in children.

External Assets:

Support

Family Support: Family continues to be a consistent source of support and love for a child's needs. both physical and emotional.

Positive Family Communication: Communication in family is open, frequent, and respectful. The child recieves praise for accomplishments and efforts.

Other adult relationships: Child receives support from adults other than parents.

Caring Neighborhood: Neighbors are friendly and support the child's sense of belonging and growth.

✓ *Caring School Climate: Teachers, caregivers, and peers at school provide a safe and welcoming environment.*

Parent Involvement in School: Parents are actively involved in the child's school success and talk about the importance of education.

Empowerment

✓ *Community Values Children: Children and included in community activities.*

✓ *Children as Resources: Child has opportunities to contribute to the community and family decisions.*

✓ *Service to Others: Child has opportunities to serve the community.*

Safety: Adults ensure child's safety while also providing space for the child's growing sense of independence.

Boundaries and Expectations

Family Boundaries: The family always knows where the child is and has reasonable guidelines for the child's behavior.

School Boundaries: Schools have clear and consistent rules. Discipline is approached in a fair and positive way.

Neighborhood Boundaries: Neighbor help monitor the child and provide feedback to parents.

✓ *Adult role models: Adults model positive and reasonable behavior. Children are encouraged to follow their example.*

Positive Peer Influence: Parents encourage child to spend time with children who are good role models or exhibit positive behavior.

High Expectations: The child is encouraged to and success is celebrated.

Constructive use of time

Creative Activities: Child participates in activities that involve creative expression weekly outside of school.

✓ *Child Programs: Child participates weekly in at least one club, organization, or sport within the school or community.*

Time at Home: Child spends time at home doing positive activities with the family or playing.

Internal Assets:

Commitment to Learning

✓ *Achievement Motivation: Child is encouraged to remain curious and shows interest in academic success.*

✓ *Learning Engagement: Child enjoys learning and is excited to go to school.*

Homework: Child can complete homework, with the appropriate support necessary to do so.

✓ *Bonding to School: Child feels a sense of belonging at school.*

Reading for Pleasure: Child reads outside of school

Positive Values

✓ *Caring: Adults help child further develop empathy, understanding, and a desire to support others.*

✓ *Equality and Social Justice: Child is concerned about the rules and being fair to others.*

✓ *Integrity: Child develops sense of right and wrong.*

Honesty: Child develops ability to recognize and tell the truth.

✓ *Self-Regulation: Child develops skills in emotional regulation and understanding the importance of healthy choices.*

Social Competencies

Planning and Decision Making: Child thinks and plans activities, with appropriate adult support.

Interpersonal Competence: Child looks to build friendships and learns about self-control.

Cultural Competence: Child learns about own identity and is encouraged to interact with children of different backgrounds.

✓ *Resistance Skills: Child is learning to recognize risky situations and seek help when needed.*

Peaceful Conflict Resolution: Child learns how to resolve conflicts in a healthy and non-disruptive manner.

Positive Identity

✓ *Personal Power: Child develops a growing sense of influence and control over what happens.*

✓ *Self-Esteem: Child feels an internal sense of value and feels values by others.*

Sense of Purpose: Child is open to new experiences and imagines future activities.

✓ *Positive view of Personal future: Child has a growing curiosity about the world and their place in it.*

Traditional Design Considerations

Overview

This thesis makes the claim that biophilic design patterns should be implemented in all elementary schools for the well being and success of students. Schools across the world already utilize and showcase biophilic patterns, both intentionally, with the benefits of biophilia in mind, and unintentionally. In order to understand how biophilic design patterns may be better incorporated into school design, it is important to first understand the major factors that currently impact school design, how they impact student well-being and success, and if these factors are compatible with biophilic design.

Though biophilic design has many significant benefits, it should be noted that a combination of many considerations and design factors are necessary to optimize student learning and well being. A longer list of considerations and design factors can be found on page 15. This section explores two considerations from the list that seem to have the greatest impact on school design and largest impact on students.

Security and Safety

There are many factors and considerations that go into school design, including code, design standards, and educator/student needs. The first major consideration is safety and security. Feeling unsafe at school can significantly impact students' peace of mind, ability to focus, and anxiety levels. Due to the increase in school shootings, designing a school that is equipped to protect students from such acts of violence is critical. Though security measures are crucial in schools, if only the physical safety of students is considered there may be adverse mental impacts that overshadow the relief and comfort that students feel in a well-equipped and protected school. Schools can quickly begin to feel like a prison if security measures are installed heavy handedly and without thoughtful consideration for the mental wellbeing of students. While security measures such as double locking entry doors, bullet proof glass, and security/police are effective, they may not be the best option for students' mental health as they can perpetuate "prejudices as well as harmful paranoia and anxiety." (Flynn)

Nicki Cole sheds light on this correlation in her essay "Understanding the School-to-Prison Pipeline." Cole states that "the school-to-prison pipeline is a process through which students are pushed out of schools and into prisons. In other words, it is a process of criminalizing youth that is carried out by disciplinary policies and practices within schools that put students into contact with law enforcement." (Cole 1). While this process emphasizes factors such as school correctional policies, many of the ideas and impacts of this pipeline are applicable to the design of a school. Cole explains the sociological theory of deviance, also known as labeling theory, which states that "people come to identify and behave in ways that reflect how others label them." (Cole 3). Cole applies this theory directly to the school to prison pipeline, explaining that "being labeled as a "bad" kid by school authorities or student resource officers, and being treated in a way that reflects that label (punitively), ultimately leads kids to internalize the label and behave in ways that make it real through action. In other words, it is a self-fulfilling prophecy." (Cole 3). Cole also references a study that showed how "increased surveillance and attempts at controlling "at-risk" or deviant youth ultimately foster the very criminal behavior they are intended to prevent." (Cole 4). This concept is eye opening as it can be directly applied to school designs with overt security measures. Students who see metal detectors and police presence may begin to subconsciously label themselves as dangerous or problematic, leading to negative feelings and low self-esteem. This also often leads to behavioral issues as students begin to act in ways that reflect their environment. Proven impacts of the school-to-prison pipeline show that designers must consider how to protect students in a way that does not harm their mental health or lead to additional issues.

In addition to major public safety issues, architects must consider the safety of students on an average day. Designing to minimize

opportunities for bullying is significant in improving and protecting the mental health of students as bullying has severe and long-lasting negative impacts. According to Violence Prevention Works, students who are bullied as children are more likely to struggle with depression and low self-esteem throughout their life (How Bullying). In addition, in schools in which bullying is common, students generally feel unsafe, insecure, and dislike school. School bullies often target students in secluded areas of a school, such as the hallways and stairwells. Allowing for more visibility within classrooms and clear connections between classrooms reduces the number of places where students are vulnerable and may be targeted. By designing to prevent bullying, the school as a whole becomes a more welcoming and safe space in which students are able to develop appropriately and protect their mental health.

The Annie Purl Elementary school is an excellent example of using design to combat bullying. The classroom walls are floor-to-ceiling glass, and every classroom is connected through a central collaboration space that is visible from within the classrooms. This connection and level of transparency creates a more open space and less opportunity for bullying.

The last major component of safety and security is adult supervision, specifically regarding the balance between supervision and independence. The need to be independent plays a large role in the development of students, therefore design for safety must consider both the physical wellbeing of students as well as their psychological needs. Tom Dobbins explores this idea in his article "Shaping the Future: What to Consider When Designing for Children". Dobbins explains that as children begin to develop a strong desire to be independent and use the new skills they are learning, it is important that school design encourages liberation and independent exploration (Dobbins). This can be accomplished through spaces that are tailored to the children and can be navigated without the assistance of adults. While adult supervision and access is necessary, children are free to exercise their growing desire to be independent. This type of design might be executed in the playground of schools. The Five Fields Play Structure is an example of design that showcases this spirit of independence and liberation for children through the creation of small spaces within the structure that adults can access but cannot move through as quickly as children can. The advantage that the children have in the space due to its scale cause them to feel more ownership over the play structure, which leads to feelings of independence. If schools are designed in a way that allows for teachers to supervise without students feeling too heavily monitored or confined, this can positively contribute to their development of self-confidence and independence.

Individualization/Flexibility

The next consideration that will be explored is individualization. Peter Barrett and Dr. Yufan Zhang explore the concept of individualization in "Optimal Learning Spaces: Design Implications for Primary Schools".

> *"As an individual matures their brain builds a very personal set of connections between primary reinforces (basic needs) and complex representations of secondary reinforces (features in the world). Taken together with the situated nature of memory, these personal value pro- files lead to highly individual responses to space. This provides a sound basis to raise the potential importance of 'individualisation' as an additional, key, underlying design principle."* (Barrett 22).

It is clear that individualization is crucial as children are building complex and personal connections at their own pace, furthering their mental development. Individualization consists of two components: personalization and particularization. Personalization "concerns an individual's preferences owing to their personal life experiences of spaces" while particularization "concerns accommodating the functional needs of very specific types of users, for example learning and way finding in the context of age and physical requirements" (Barrett 22). Both aspects of individualization are significant in

designing a space that supports student growth. Without individualization, students would not be able to develop properly and at their own pace, which would lead to significant mental and psychological issues.

Designs that allow for choice are crucial in regards to personalization. "Physiology and psychology research indicates that personalization of space is an important factor in the formation of an individual's identity and sense of self-worth." (Barrett 23). A similar concept in the adult word is the desire of working professionals to customize their office or cubicle to make it their own. This type of personalization cultivates a positive sense of self, pride, and ownership. In school design, personalization may look like providing multiple intimate and smaller scales spaces within the larger classroom so that students can choose where to read, play, or nap, as well as have a space that they feel is their own. It may also look like providing plain desks and cubbies to students that they can decorate and design to their liking.

Flexibility is also significant in supporting particularization as it allows for students to develop both independently and as a group as they move up grade levels. Considering that students, even those among the same age group, develop at their own pace, it is imperative that schools can accommodate a wide range of student capacities. In addition, students learn in different ways and different lessons require different settings. The classroom is where students spend the most time in school, "Therefore, it is required to provide opportunities for the greatest flexibility to anticipate changes in pedagogical goals and educational programmes" (Barrett 25). One way that design can accommodate flexibility is through furniture that students and teachers can move as they see fit. This also contributes to the development of student's independence as they can further personalize the classroom to their own liking. Large classrooms with multi-use spaces also support flexibility. While Barrett and Zhang emphasize particularization in relation to flexible classrooms, it is also important to recognize that flexibility leads to personalization as well.

Though Barrett and Zhang did not cover this idea, it should be acknowledged that flexibility supports students with special needs, such as those who are autistic or have faced trauma (Dobbins). Social Sensory Architectures is a research project that explores how variations of tactile architecture can be therapeutic to children with autism. Also, Catalytic Action works with refugee children to provide play structures that children have control over, creating a sense of ownership and belonging (Dobbins). These two examples show how flexible spaces are significant for a range of abilities and emotional states – one size does not fit all in elementary school design.

In addition to these considerations, there are six important design elements that go into successful school design, including daylight, indoor air quality, acoustic environment, temperature, classroom design, and stimulation.

BIOPHILIC DESIGN PATTERNS

Strategies for Elementary Schools

Overview

This chapter proposes 12 design patterns for elementary schools based on the principles of biophilia. The patterns are adapted from Terrapin's "14 Patterns of Biophilic Design" and revised with a focus on elementary school design and applications.

The design patterns included are:

1. Visual connection with nature
2. Non-visual connection with nature
3. Non-rhythmic sensory stimuli
4. Thermal and airflow variability
5. Presence of water
6. Connection with natural systems
7. Dynamic and diffuse light
8. Biomorphic forms and patterns
9. Material connection with nature
10. Complexity and order
11. Prospect
12. Refuge

When choosing patterns to incorporate in an existing school, it is important to consider:

> Which patterns would be the most impactful based on what is missing from the school?
>
> Is it possible to build off existing structures/systems to create or enhance their positive benefits?
>
> What are the students currently missing mentally, physically, academically, or socially?

In the design of new schools, factors that should be considered are:

> Does the site provide opportunities for biodiverse landscape or views?
>
> What is the local ecology?
>
> Are there design strategies that incorporate multiple patterns and benefits?

It likely will not be possible for every design pattern to be incorporated in a single school due to budget, program, or site constraints. Rather than incorporating many patterns, it is more significant that the patterns incorporated are intentional and specific to the community or site. If this is accomplished, the patterns will lead to significant benefits.

The benefits are organized into four categories: Mental Health, Physical Health, Academic Success, and Social Benefits. Mental health benefits relate to any benefits that children experience emotionally or psychologically. A majority of the benefits in this category relate to a reduction in stress. Physical health benefits are included and supported by data and research. Academic success relates to any factors that allow students to learn or retain information more effectively. The last benefit is social benefits which relates to anything that allows students to form friendships, healthy relationships, and contribute to society.

The connection of each pattern to the four senses (sight, smell, touch, and sound) is also recognized in order to convey the varied strategies that can be used to accomplish a pattern and the connections across patterns.

Touch *Smell* *Sound* *Sight*

Visual connection with nature

Definition:
A view to elements in nature or natural processes, such a garden, forest, rain, or pond.

Mental Health:

- Reduced stress
- More positive emotional functioning
- Reduced sadness
- Reduced anger
- Better attitude
- Increased overall happiness
- Improved self-esteem

Physical Health:

- Lowered blood pressure
- Lowered heart rate

Academic Success:

- Improved concentration
- Reduced attentional fatigue
- Improved mental engagement/attentiveness
- Prolonged interest

Social Benefits:

- Reduced aggression

Design strategies:

- Biodiverse landscape around school
- Windows that looks out to a garden or forest
- Classroom aquarium
- Central courtyard with green spaces that the classrooms are clustered around
- Green spaces, such as planters or green walls, in common spaces

Overview

A visual connection to nature is one of the most straightforward and easily implemented of the patterns included.

Considering how dense and urbanized our cities have become, a visual connection with nature exists in daily life through intentional designs. Street trees, community gardens, and man made ponds are some examples of how a visual connection is created. Neighborhoods with a pond can be more desirable than those without. City codes enforce certain standards of landscaping for new projects. Homes with a waterfront view are more expensive than those without. All around us, we see the human desire and preference for seeing from within or around our built environments. Schools should be no different.

A student looks out of his classroom window and sees a garden.

A skylight in the hallway looks up to the clouds.

A green wall in the cafeteria.

A fish aquarium or plant terrarium in the library.

The opportunities to include a visual connection to nature in a school are endless and can fit any budget or project. New schools can be designed intentionally with windows that look off to a natural landscape, rather than hard-scape. Existing schools can invest in green walls or plants.

Pairs well with...

Material Connection with Nature

Research

The benefits of spending time in nature increases with greater biodiversity. Specifically, diverse plants and tree species are more effective than diverse animal life since humans are more likely to perceive differences in plants than differences in birds. Providing green space impacts users at varying degrees based on how diverse the space is (Fuller 393).

Viewing nature for ten minutes before a mental stressor, such as a test or difficult lesson, triggers activities within the body that occur when resting. Viewing nature not only helps with stress recovery after an incident, but encourages future healthy stress responses and recovery (Brown 5567).

Experiencing nature has the most impact within the first five minutes (Barton and Pretty 3949).

Though there are benefits to viewing nature artificially, for example on a screen, stress recovery is 1.6 times faster when the view of nature is through a window (Kahn et al. 196).

Classroom Aquarium.

Windows that look out to a garden or forest.

Green spaces, such as planters or green walls, in common spaces

Biodiverse landscape around the school.

Non-visual connection with nature

Definition:
An auditory, haptic, olfactory, or gustatory stimulus that references nature, natural processes, or living systems.

Mental Health:

Inspires curiosity

Physical Health:

Positive impact on healing process
Improved immune system

Academic Success:

Reduces cognitive fatigue
Improves motivation

Social Benefits:

Reduced aggression

Design strategies:

Open windows allow for the sound and feel of natural ventilation
Sound of rain
Smell of grass
Garden with edible plants
Water fountain in a central area that students can hear from multiple locations
Perfume, air freshener, or essential oils that contain natural scents (flowers, grass, or wood)

Overview

Experiencing nature is not one dimensional. Waves in the ocean make a distinct sound when they hit the shore. There is a smell we expect to experience when grass is wet. Sand running through fingers is a soft sensation. If waves stopped making a crashing noise, wet grass became odorless, and sand felt like thorns, nature would no longer make sense. The experience would be completely different.

The benefits we feel when in nature is not only due to what we see, but all of the sensory components that make up the experience. Biophilic design in a school environment must be approached similarly as the different senses each contribute a portion of the whole experience.

Students hear birds chirp through their classroom window.

The smell of an essential oil wafts through the school.

A patch of grass in a common space that students can study on.

A day in school is filled with many sensory experiences for students. The chatter of classmates, feel of eraser shavings on a desk, and smell of the playground tar ground are only a few of the hundreds of experiences students might have in a day. How could a student's experience change if some of these moments were based in biophilia?

Pairs well with...

Connection with Natural Systems
Material Connection with Nature

Research

Nature sounds accelerate psychological restoration 37% faster than urban office sounds (Alvarsson et al. 1043. Nature sounds also reduce cognitive fatigue and increases motivation (Jahncke et al. 380).

There is a strong connection between sensory and auditory systems (Jahncke et al. 380).

Certain essential oils, such as lavender, promote calmness (Terrapin).

Touching real plants induces relaxation (e.g., Koga & Iwasaki 7).

The sound of rain playing through classroom speakers.

Edible plants for students to eat while supervised in the classroom garden.

Th smell of grass wafting in through an open window or simulated through essential oils in the class. .

Wind coming in through an open window.

Non-rhythmic sensory stimuli

Definition:
Stochastic connections with nature

Mental Health:

Reduced mental fatigue

Physical Health:

Physiological restoration

Design strategies:

Mechanical or digital simulation of natural stimuli

A window planter with plant species that attract bees, butterflies, or other pollinators

Motion that is non-rhythmic, such as a butterfly fluttering or leaves rustling in the wind.

Overview

Nature is unpredictable - the clouds rolling by, birds chirping, and breezes in the air are experiences we expect when enjoying time in nature, but not elements that we can anticipate at a precise time. The serendipity of natural elements that are familiar allows one to feel relaxed while remaining privy to each new bird that chirps or a sudden gust of wind that arrives.

Nature in the classroom should have the same qualities - biophilic design should attract the attention of students in a subtle and non intrusive way. This helps against mental fatigue by providing students with momentary mental respite.

A curtain swaying in the wind might attract the attention of a student who is becoming fatigued while focusing on a task.

The sudden smell of flowers might ground a student whose thoughts have drifted elsewhere.

This pattern may seem counterintuitive as young students often have trouble focusing in the classroom. It is important to recognize that a lack of focus might be stemming from mental fatigue or other distractions in the classroom. The benefit of this pattern is that it provides a break for students, without being time consuming or intrusive.

Pairs well with...

Visual Connection with Nature
Non-visual Connection with Nature
Connection with Natural Systems

Research

The eyes' lenses contract after staring at a computer screen or completing a task with a visual focus. If contracted for more than 20 minutes, this can cause fatigue and headaches. Brief distractions can provide respite and allow for the muscles to relax (Terrapin).

Curtains or fabrics that sway in the wind.

Skylight or windows that show the clouds rolling by.

Bees buzzing.

Water babbling.

Thermal and airflow variability

Definition:
Subtle changes in humidity, air flow, and air or surface temperatures.

Physical Health:

Increased comfort

Academic Success:

Decreased boredom and passivity
Improved concentration
Better student performance
Increase in ability to access short term memory
Increased productivity

Design strategies:

Operable windows
Works areas with external balconies
Visible mechanical ventilation
Seating options with different levels of solar gain, such a seat outside in the shade or a seat indoors near a sunny window
Materials or surfaces in the classroom with varying levels of conductance, such a metal table with wood chairs

Overview

The amount of wind can make an outdoor seating delightful or frustrating. On a hot day, a gust of wind is a welcome arrival. If the weather is too cold, wind can worsen an already uncomfortable setting. The same idea applies to our built environment and indoor settings.

Thermal and airflow variability is a major design consideration in the design of every building. Proper ventilation is imperative in creating both a comfortable and safe environment.

Mechanical systems are typically relied upon to control the temperature and airflow in a space. While this is important, there are other ways to create thermal comfort through the architecture of the space and choice of materials.

Pairs well with...

Non-visual Connection with Nature

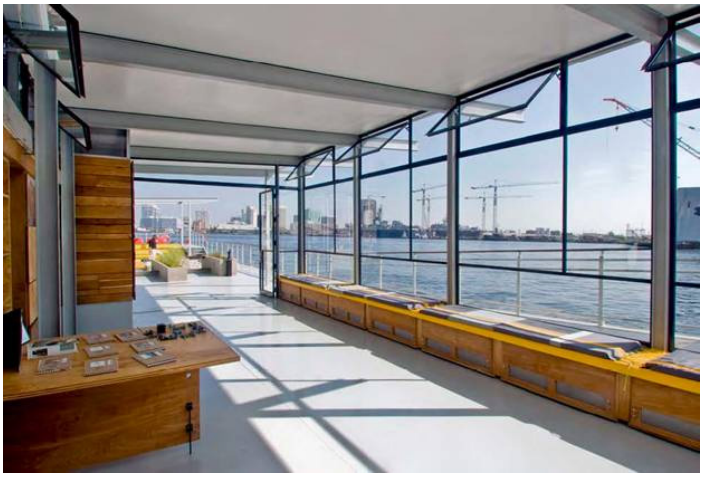
Research

Moderate levels of sensory variability can reduce fatigue and passivity (Heerwagen).

Concentration can be improved by elements of "soft fascination", such as light breezes or natural movements (S. Kaplan 44).

A variety of thermal conditions can lead to better student performance (Elzeyadi 50).

Changes in thermal velocity may improve access to short term memory (Wigö 46).



Operable windows.

Classroom surfaces with varying levels of conductance.

External walkway that connect classrooms.

Seating areas with varying levels of solar exposure.

Presence of water

Definition:
Subtle changes in humidity, air flow, and air or surface temperatures.

Mental Health:

Reduced stress
Increased feelings of tranquility
Improved mood

Physical Health:

Lowered heart rate
Lowered blood pressure

Academic Success:

Improved concentration
Improved memory restoration
Enhanced perception

Social Benefits:

Increased self-esteem

Design strategies:

Water fountains
Aquariums
The color blue

Overview

People often look to water as a break from the hustle and bustle of daily life, both intentionally and unintentionally. There is something intuitively relaxing about water that affects us as humans.

When walking past large bodies of water, we often pause and look. When choosing a place for a picnic, there is always something inherently more desirable about sitting by the lake than sitting somewhere with no lake. If you look up relaxing sounds to listen to, many of these will be water based, such as the sounds of a light rainfall or waves hitting the shores.

Though water is so attractive to humans, it is hard to incorporate into daily life, aside from the necessities that include water, such as drinking or bathing. Many homes do not have water front views and water features are expensive to install.

Part of the beauty of this pattern is that it uses our feeling towards water to explore how the benefits of water can be gained, even if it is not directly present.

Pairs well with...

Visual Connection with Nature
Non-visual Connection with Nature

Research

Landscapes with water are encourage a higher restorative response than those without. Natural landscapes without water and urban landscapes with water promote a similar restorative response (Jahncke et al 380).

In comparison to green spaces without water, those with water prompt increased feelings of self-esteem and better mood (Barton & Pretty 3949).

Auditory and tactile presence of water reduces stress (Pheasant et al. 507).

Water fountain at the school's entrance.

Classroom aquarium.

Blue paint on classroom walls.

Tranquility ponds in the courtyard.

Dynamic and Diffuse Light

Definition:
Varying levels of intensity of light or shade that change as time passes. This pattern also includes the design of well lit spaces.

Mental Health:

Positive mood
Higher production of serotonin when exposed to blue light

Physical Health:

Less dental decay

Academic Success:

Increased productivity

Design strategies:

Daylight from multiple angles
Light distribution
Personal dimmer controls
Lights that change color based on activity or time of day

Overview

In thinking about light and nature, the first thought is typically about daylight or sunlight. Sunny days are usually related to happy days - especially for children. It means time outside and cold treats. Even as adults, many of us can relate to the natural happiness that arrives when the sun comes out, especially in Washington.

We experience daylight every day, whether we are sitting inside near a window or walking around outside. Though this is the case, there are ways that daylighting and even artificial lighting can be used more strategically to build off our preferences and further support students, aside from their mood and happiness.

Pairs well with...

Visual Connection with Nature

Research

Students who were exposed to quality daylighting has a more positive mood and less dental decay than those who were not (Nicklas & Bailey 6).

Children preform better in daylighted classrooms with views (Terrapin).

Light distribution.

Light dimmer.

Daylight from multiple angles.

Lighting color based on circadian cycles, such as Blue light during the night or nap time.

Connection with natural systems

Definition:
An awareness of natural systems or processes

Social Benefits:

Perceptual shift and greater awareness of surrounding
Inspires environmental stewardship

Design strategies:

Work spaces with patios or gardens
Plants that are seasonal
Outdoor classrooms where teachers can identify different processes or species to students
Rainwater harvesting through water cistern, rain garden, or rain chains
School garden that children can participate in

Connection with natural systems

We cannot expect students to be stewards of their environment if they are disconnected from the natural processes that make up the world around them.

Students living in urban areas are far removed from natural processes. Children watch their parents buy food from a grocery store without any indication of where the food came from. They see water come from their kitchen sinks, but do not have an understanding of where that water comes from or how it is collected. The wood table in their kitchen was bought from a furniture store, but do children know where the wood came from?

Food, water, and materials have become elements that are taken for granted and seen as never ending resources. This is the nature of living in an urban space.

Schools are one place in which students can be better introduced to natural processes, such as how water is collected or how food is grown. This both teaches students about the world around them and gives them a deeper appreciation for the natural environment.

Pairs well with...

Visual Connection with Nature
Non-visual Connection with Nature

Research

Gardening promotes environmental stewardship and reduces perceptions of fatigue (Yamane et al. 40)

Seasonal plants that students can identify.

Visible water cistern or system for water collection.

Shared garden that students tend to.

Work spaces outdoors for students.

Biomorphic forms and patterns

Definition:

Symbolic arrangements that reference patterns in nature

Mental Health:

Reduce stress

Academic Success:

Improve concentration

Design strategies:

Organic shapes
Curves
Natural colors
Fractals
Spirals
Geometric patterns

Overview

Children do not color inside the lines. They draw shapes that are not perfect as they learn to have a steady hand. Their world does not exist as perfect lines and geometries - rather, their world has elements of natural shapes and soft lines.

Their classroom and school settings should reflect their natural disposition to organic forms and should not impose harsh man-made geometries on them.

This pattern connects to a child's natural preferences and abilities, while also allowing students to see that the world they are in is imperfect.

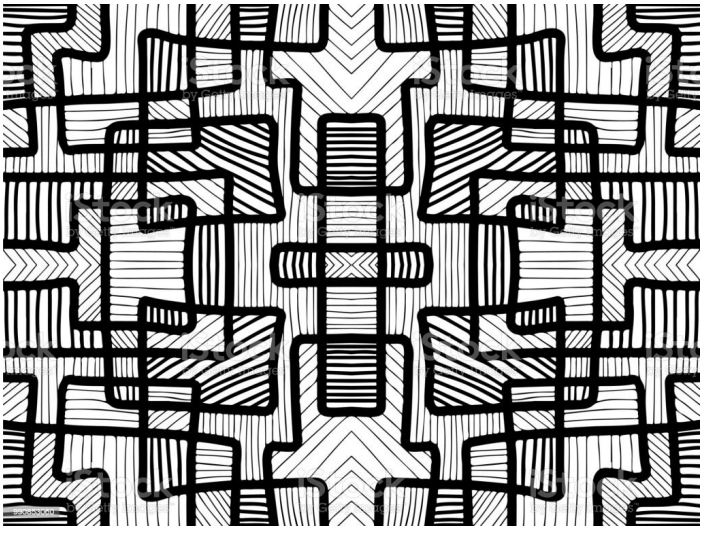
Pairs well with...

Visual Connection with Nature
Complexity and Order

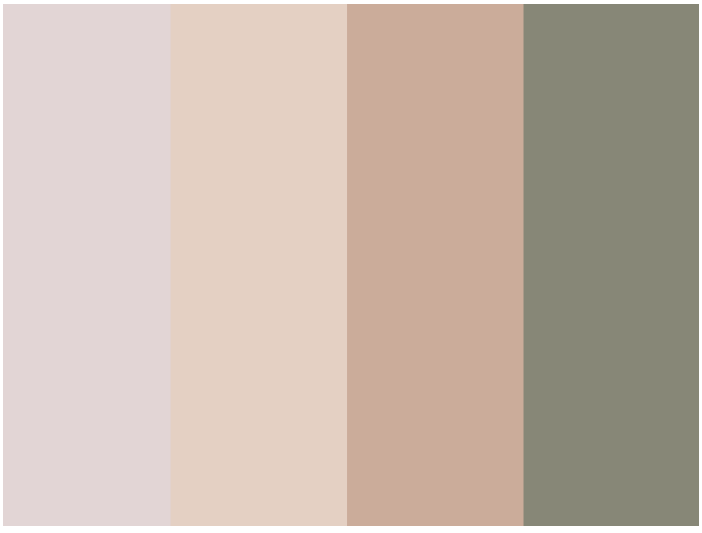
Research

The human brain may perceive biomorphic forms as symbolic representations of life (Terrapin).

The presence of biomorphic forms may reduce stress due to an induced shift in focus and improve concentration (Joye 325).



Wallpaper with geometric patterns.



Walls and furniture feature a natural color pallet.

Non-rectilinear classroom desks and/or furniture.

Curvy outdoor benches.

Material connection with nature

Definition:
Materials that reflect elements of nature or the local ecology, thus creating a sense of place

Physical Health:

Increased comfort
Decreased blood pressure

Academic Success:

Improved creative performance

Design strategies:

Wood ceilings and floors
Stone walls or floors

Overview

Many students have limited access to the natural environment. They may live in apartments and not have access to a green backyard. Or they may live in a dense area that has few opportunities for play outdoors.

School is one place for all students, regardless of their background or home conditions,to have access to the natural environment.

Considering how much time students spend inside their classroom, it is crucial that design strategies bring the elements of the outdoors or natural environment inside. One way to accomplish this is through natural materials and colors inside of the classroom.

Pairs well with...

Visual Connection with Nature

Research

Exposure to the color green before a task increases creativity (Lichtenfeld et al. 792).

Interior spaces with 90% or more of wood creates a highly restorative environment. A space with a moderate ration of wood (45%) decreases blood pressure and increases pulse rate (Tsunetsugu, Miyazaki & Sato 14).

Shades of green used in wallpaper, paint, or furniture.

Stone pathways leading to class garden.

Wood surfaces, including walls, floors, or ceilings.

Unprocessed wood elements of decor.

Complexity and order

Definition:
Spatial hierarchy that reflects hierarchies found in nature

Mental Health:

Reduces stress

Design strategies:

Repetitive and symmetrical shapes
Patterns in wallpaper or floor
Exposed structure and systems
Spandrel and window hierarchy
Organized floor plan

Complexity and order

Creating a stimulating environment for students is a primary goal of curriculum and lesson plans. Ensuring that students remain engaged so that they can follow along with the material and not fall behind is imperative. This idea translates to the design of the classroom.

A dull and uninteresting space will cause students to loose interest and drift off elsewhere. A complex space that students can understand implicitly proves to students that they can understand the world around them, or more specifically, the lessons in the classroom.

It should be noted that it is important to create a balance between stimulation and restoration. Students should not feel overwhelmed by their surroundings and their environments should not detract from their learning. Similar to other patterns, a balance in opposing ideas or forces is important.

Pairs well with...

Biomorphic Forms and Patterns

Research

Nestal fractal designs reduce stress and stimulate the mind greater than designs that limit complexity (Salingaros 25).

Overly complex designs may induce stress, headaches, and nausea (Taylor 249).

Wallpaper or posters with a complex pattern may be used.

Hallway tiles placed in an interesting way.

Window mullions can create complexity and order by repeating a similar pattern.

The school's floor plan can be complex - the hallway can connect to smaller breakout spaces.

Prospect

Definition:
Unimpeded view over a distance

Mental Health:

Reduction in stress, including when alone or in an unfamiliar environment
Reduced perceived vulnerability

Physical Health:

Increased comfort

Academic Success:

Reduction in boredom
Reduced fatigue

Social Benefits:

Reduced irritability
Greater sense of awareness

Design strategies:

Stairwells at perimeter with glass facade and interior stairs that are connected to interior
View to outside span of nature
Open floor plans
Balconies or catwalks
Transparent materials

Prospect

People tend to desire an awareness of their surroundings. Curiosity about what is around us is one reason for prospect. Safety and security is another reason - if we can clearly see our surroundings and relationship to the context, there are less unknowns.

Students should be able to place their school in its context or urban environment. More so, they should be able to place themselves in their school context.

Can students identify where they are in relation to their classroom?

Are students able to identify their location in relation to a common space?

This ability to identify location gives students both peace of mind and critical thinking skills as they are able to imagine how the parts of something make up a whole. They are also able to think further out than their own location, which gives them a greater awareness.

Pairs well with...

Refuge

Research

Responses to prospect include reduced stress (Grahn & Stigsdotter 271), improved comfort, and a greater sense of awareness (Herzog & Bryce 381).

Prospect also reduces boredom, fatigue, and irritation (Clearwater & Coss 410).

Mezzanine areas allow for prospect within the school as well as additional space.

Bridges that lead into the school create a high vantage point for students.

School stairs are enclosed by windows so that students can view their surroundings.

Exterior walkways allow students to view their surroundings while moving between classes.

Refuge

Definition:
A place for withdrawal with protection from behind and overhead

Mental Health:

Stress reduction
Enhanced restoration process
Reduced perceived vulnerability
Increased perception of safety

Academic Success:

Reduced fatigue
Improved concentration
Improved attention

Social Benefits:

Reduced irritability

Design strategies:

Nooks in the classroom
Smaller break out spaces
Playground with multiple levels
Lowered ceiling conditions

Refuge

Both children and adults need a place where they can escape from the noise and stress of everyday life. School can oftentimes be overwhelming to students, both academically and socially. For this reason, it is crucial that a place of refuge is accessible to students.

Refuge in a school setting can be as simple as a reading nook or a nap time pod. The key with this pattern is to balance privacy with safety. Students should feel that they have a private space to go to, while teachers should still be able to observe and monitor the students.

Pairs well with...

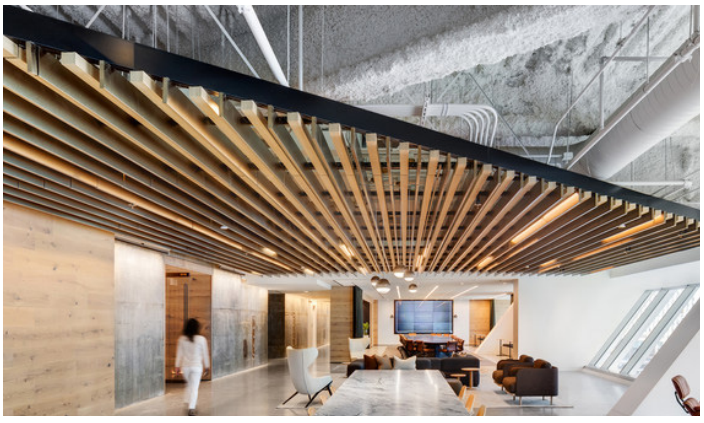
Prospect

Research

Restoration is less impacted by size of a green space and more impacted by the ability to be immersed in an enclosed space (Nordh, Hartig, Hägerhäll & Fry 323).

Refuge and prospect should be balanced for optimal outcomes (Appleton 282).

Refuge reduces irritation, fatigue, and vulnerability. It can also improve concentration and attention (Petherick 100).



Dropped ceilings can make an open space feel more private.

The placement of furniture can create a place of refuge,

Small reading nook in the classroom provides a quiet and semi-private space for students.

Movable partitions are a cost effective way to create flexible places of refuge in the classroom.

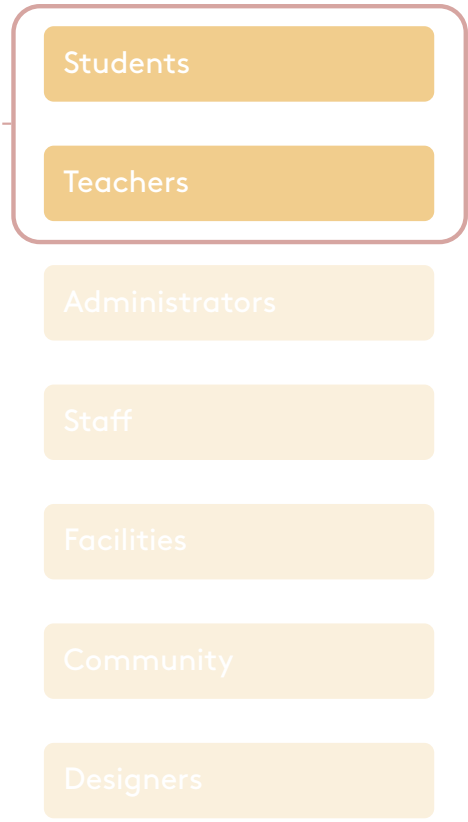
NEXT STEPS

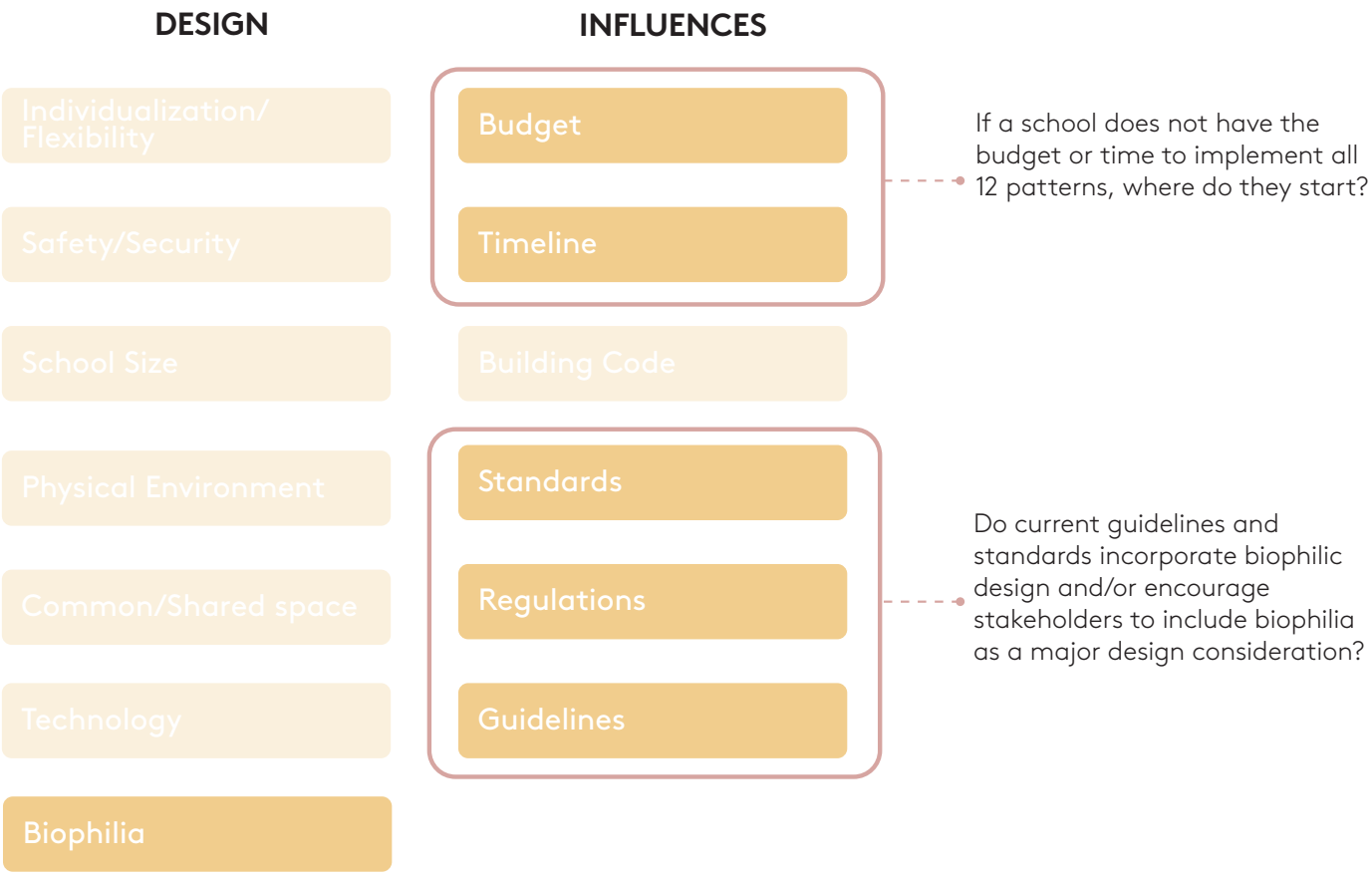
Overview

This section explores next steps for this research by analyzing what stakeholders want and current influences on whether or not biophilic design is utilized. Specifically, this section explores what teachers want, how current regulations relate to biophilic design, and what can be done if there are time and budget constraints. Future research ideas will also be explored in order to understand how this research might continue.

The goal is to understand how biophilic design might be applied in schools oustide of a theoretical lenses/framework.

Acknowledge relationship between teachers and students. What do teachers want?




DESIGN
INFLUENCES
Individualization/ Flexibility
Safety/Security
School Size
Physical Environment
Common/Shared space
Technology
Biophilia
Budget
Timeline
Building Code
Standards
Regulations
Guidelines
If a school does not have the budget or time to implement all 12 patterns, where do they start?
Do current guidelines and standards incorporate biophilic design and/or encourage stakeholders to include biophilia as a major design consideration?

Stakeholder: Teachers

Starting with stakeholders, its important to acknowledge the relationship between teachers and students. Happy and healthy teachers support happy and healthy students.

So what do teachers want?

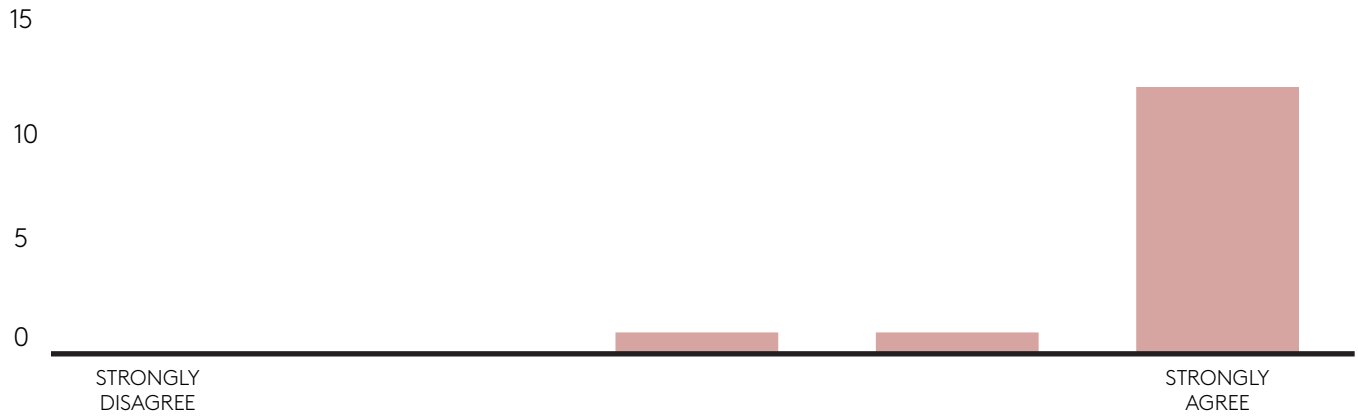
"Connections to nature in an urban atmosphere is even more imperative when thinking about design. I think it is as important to the soul as universal design is to the needs to the body."

-3rd Grade teacher in Seattle, WA

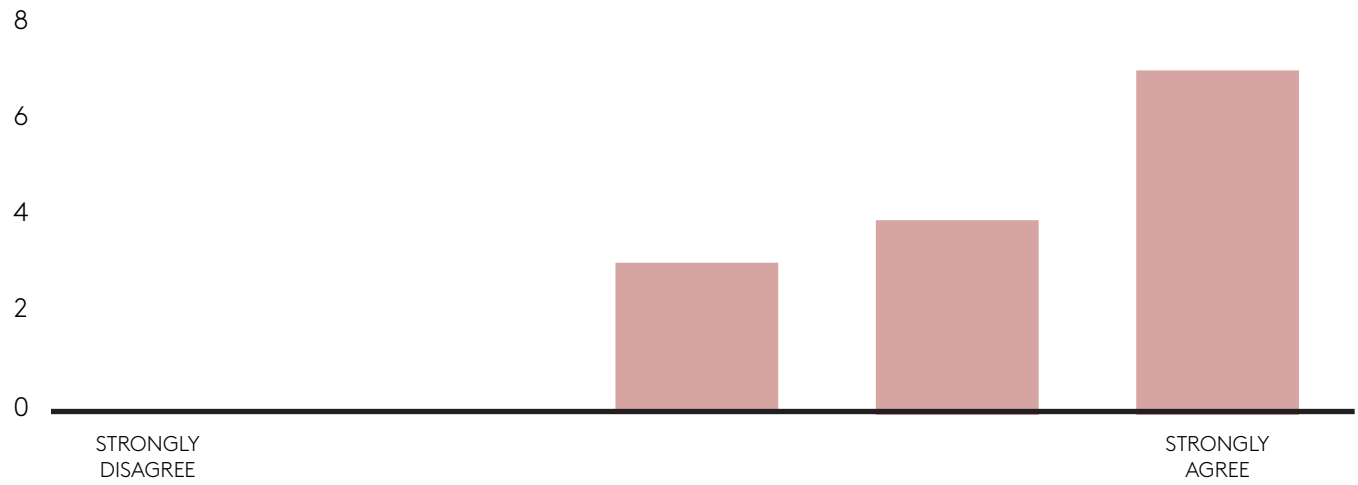
Before exploring how teachers feel about biophilia in the classroom, it's important to understand how teachers feel about their spaces and how it impacts the way they teach.

Survey questions were distributed to teachers from four elementary schools in Washington in order to gather their opinions and thoughts on classroom design. 15 teachers responded with their opinions on classroom design.

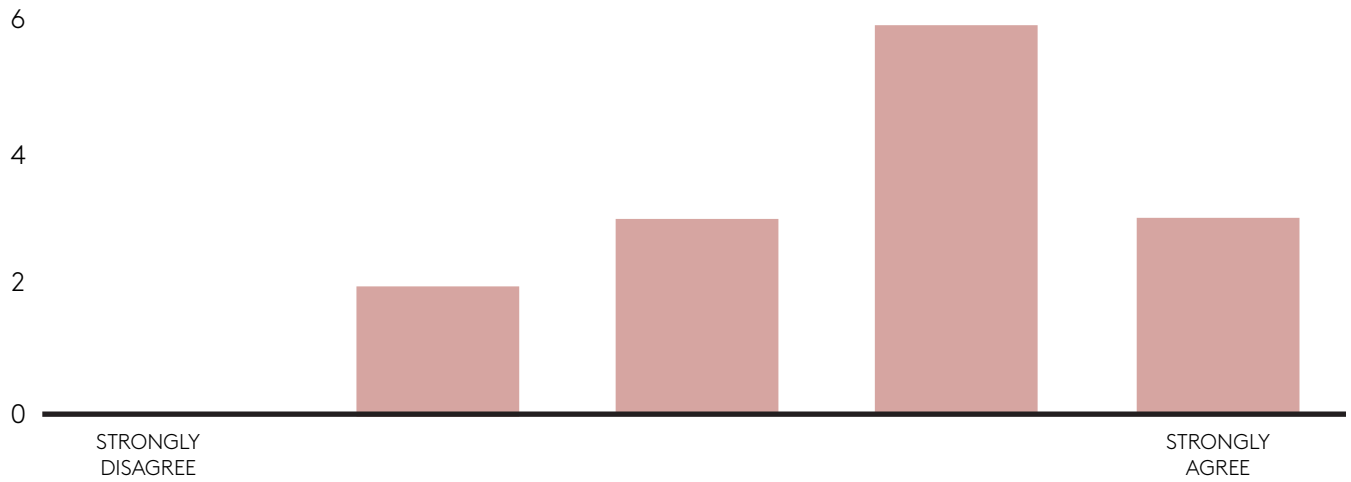
I care about the way my classroom looks.



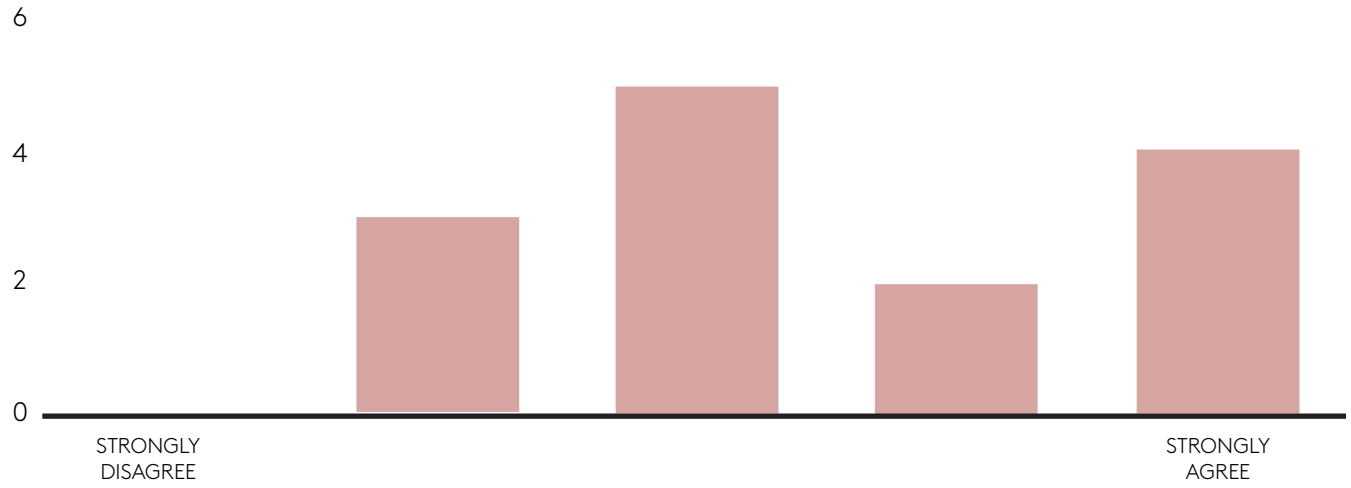
I care about the architectural finishes/materials in my classroom.



The construction materials used in my classroom make a difference in the way I feel when I teach.



Students can implicitly learn lessons from their surroundings.



The answers to these survey questions reveal that:

85.7% of teachers report feeling strongly about how their classroom looks.

50% care strongly about the architectural finishes and materials.

42.9% feel that the construction materials in their classroom make a difference in how they feel when teaching, and 21.1% strongly feel that it impacts them.

42.9% think that students can learn implicitly through their surroundings.

Though this is a relatively small survey, it indicates that teachers do care deeply about their spaces and feel that it impacts how they teach. It is likely that teachers, like their students, would benefit from the impacts of biophilic design.

Some teachers indicate that there may be an opportunity for students to learn from their surrounding, which reinforces the claim that biophilic design can support student development.

Seattle educators came together to outline their goals for school in the Seattle Publics Schools Generic Elementary Educational specifications. They drafted a list of priorities intended to help guide designers and engineers, many of which relate to biophilic design.

Some of the priorities that relate to or can be supported by biophilic design are listed here, including the desire for the building to support student needs, create a sense of place, and have interesting spatial qualities.

The building is designed with students' needs placed first

The building and campus provide opportunities for students to explore hypotheses and test ideas

The building provides spaces for individualized support services for students, including mental, physical, social, and academic support

The building conveys a sense of place

The building provides a stimulating environment

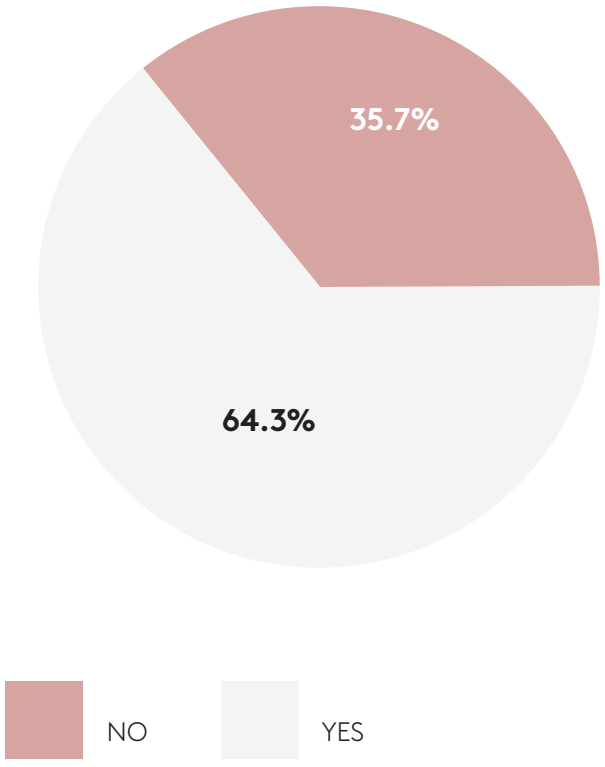
The building is pleasing in a tactile way.

The building has comfortable, fun spaces that entice kids

The building has a variety of interesting spatial types that allow for exploration.

One question that came up after reading these priorities is why is biophilia not explicitly listed, but implicitly included? To gather insight on this, I surveyed a group of elementary school teachers and asked if they are familiar with the benefits of daylight in the classroom, since this is arguably the most well known biophilic pattern after Heschong and Mahone published "Daylighting in schools". 64.3% of teachers were familiar - this percentage would likely go down for the other patterns that are not as well known.

Are teachers familiar with any of the benefits of daylight in the classroom?



One goal of the thesis is to make these patterns easily understood and digestible to help teachers and other stakeholders advocate specifically and explicitly for biophilic design patterns that support their existing goals.

Influences: Standards, Regulations, and Guidelines

Overview

The goal was to understand if guidelines and standards incorporate biophilic design or encourage stakeholders to consider it as a major consideration.

Sustainable Schools Protocol

The sustainable schools protocol was a good case study because it is intended to help Washington schools be safe and environmentally sensitive facilities. It applies to both new construction and existing facility remodels. This set of guidelines was the most directly related to biophilic design in Washington.

That being said, only 3 out of the 23 credits related to biophilic design. Those were daylight, window with an outside view, and air quality.

This is not nearly enough given the amazing benefits that biophilic design has on students and teachers' desires to incorporate them. Biophilic design should be directly incorporated into guidelines and standards in order to reflect student/teacher needs and clearly guide conversations and decisions between all the involved parties. The sustainable schools protocol is one place s to start.

Precedents

Changing guidelines, standards, and regulations may seem daunting, but it should be acknowledged that there are great precedents that show how change was enacted for the betterment of students. The movement to enforce healthier school meals is one example. In the past, the idea of enforcing healthy school lunches may have seemed unnecessary or impossible due to budget constraints. Pressure was put on the appropriate stakeholders to break these barriers so that now healthy school lunch is commonplace. Michelle Obama's "Let's Move" is another example of a widespread movement that focused on student health.

The next step for stakeholders who are inspired by this thesis to implement biophilic design is to focus their advocacy on guiding school district guidelines and state standards/regulations.

Influences: Budget and Timeline

Overview

The last part of this thesis was to imagine that all 12 patterns are widely known, understood, and proposed and understand what next.

The question of what to do if all 12 patterns can not be implemented due to timeline or budget arose. The 12 patterns were proposed with equal emphasis on each - in an ideal world, every pattern would be used, but this is not necessarily feasible.

This thesis proposes a survey tool for helping educators, students, designers, and administration choose which patterns to choose. The version of the survey shown here is for teachers and was tested on teachers - a similar set of questions may be used for students with a simplified scale. The goal is to ask teachers to rank a strategy from each of the patterns from 1 to 5 in order to understand how important it is to them. This can be used as a starting point to understand which patterns to focus on and can then be customized to ask about design strategies that are under consideration.

Surveys

To gain further insight, surveys were utilized to understand how teachers and students feel about the design patterns. Surveys were distributed to teachers in Washington elementary schools in order to create a focus group for testing the survey. Schools were selected at random to complete the survey.

The first survey question asks teachers to disclose the grade that they teach. Next, they are asked to state if they are familiar with the benefits of daylighting in the classroom (yes or no). This question provides a clue as to teacher familiarity with the benefits of biophilic design. The next set of questions ask teachers to rank one design strategy from each design pattern based on how important they are to have at school or in the classroom for the students' benefit (focus, mood, happiness, attention, academic success, etc.). This may be based on the teacher's observations or best guess. The design strategies were not tied to a specific pattern in order to simplify the survey. The strategies included in the survey are:

1. Window that looks out to a natural landscape (forest, grass, or garden)
2. Smell of grass
3. Operable Windows
4. Classroom aquarium
5. Community garden for students to work in
6. Organic Shapes
7. Wood walls, ceilings, or floors
8. Repetitive patterns in the wallpaper
9. Exterior stairs that lets students see their complete surroundings
10. Work spaces surrounded by a garden
11. Nooks in a classroom for students to use alone
12. Daylight from multiple angles

Lastly, teachers were asked to identify any elements that already exist in their schools or classrooms in order to analyze if any patterns are currently more common than others.

The student survey asked students to identify their grade. They were given the same design strategies as the teachers and asked to identify if they: Want this, do not want this, or do not care. Lastly, students were asked to identify any elements that already exist in their schools or

Instructions: Rank the following elements based on how important they are to have at school or in your classroom for the students' benefit (focus, mood, happiness, attention, academic success, etc.). This may be based on your own observations or best guess.

1 2 3 4 5

MUST HAVE — NEUTRAL — MUST NOT HAVE

- Window that looks out to a natural landscape (forest, grass, or garden)
- Smell of grass
- Community garden for students to work in
- Operable windows
- Organic shapes
- Wood walls, ceilings, or floors
- Classroom aquarium
- Exterior stairs that lets students see their complete surroundings
- Repetitive patterns in the wallpaper
- Work spaces surrounded by a garden
- Nooks in a classroom for students to use alone
- Daylight from multiple angles

Survey Scoring

1 - - - - 25 POINTS X # OF TEACHERS

2 - - - - 20 POINTS X # OF TEACHERS

3 - - - - 15 POINTS X # OF TEACHERS

4 - - - - 10 POINTS X # OF TEACHERS

5 - - - - 5 POINTS X # OF TEACHERS

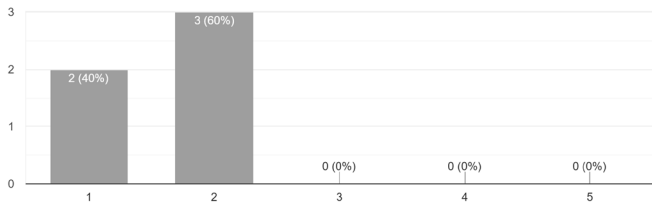
TOTAL POINTS

---

25 POINTS X # OF TEACHER RESPONSES

x 100 = %

Window that looks out to a natural landscape (forest, grass, or garden)



(25 POINTS X 2 TEACHERS)

\+ (20 POINTS X 3 TEACHERS)

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110 TOTAL POINTS

110

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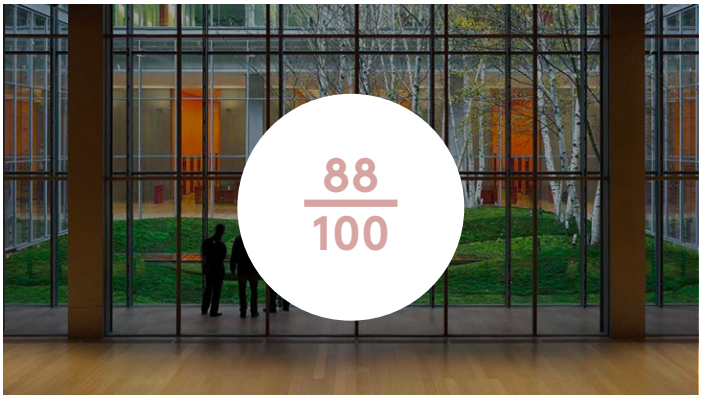
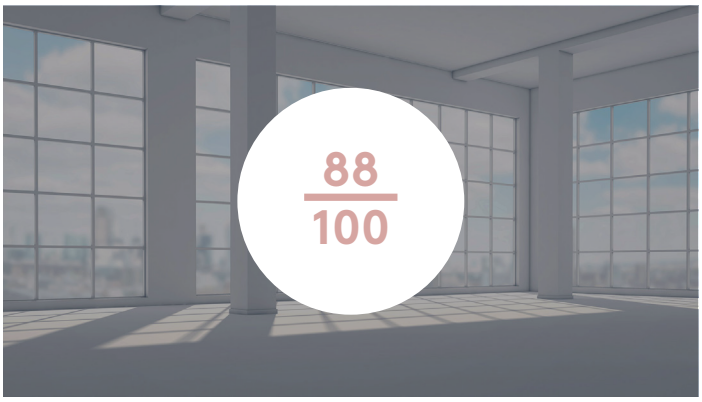
25 POINTS X 5 TEACHER RESPONSES

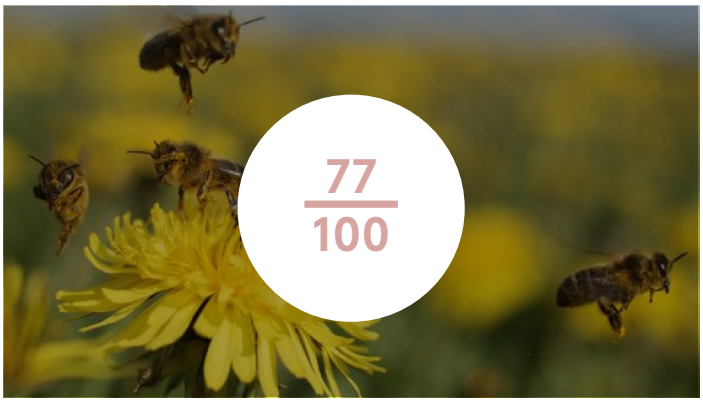
x 100 = 88% or 88/100



Visual Connection to Nature



Dynamic and Diffuse Light



Non-Visual Connection to Nature

Presence of Water

Based on scores from the focus group, visual connection to nature and dynamic and diffuse light would be implemented.

It's important to recognize that this survey has limitations - it can not propose every possible design strategy and does not test how students or teachers would be impacted by these patterns. Instead, it is a place to start the conversation about how to begin implementing biophilic design patterns more widely in schools. It's also important to note that these scores will very likely change as students and teachers are introduced to the biophilic design patterns guide and gain more knowledge about the benefits of each pattern. The surveys should be used holistically with the rest of the thesis to spark and continue conversations about biophilic design in elementary schools.

Future Research

The research in this thesis highlights many ways in which elementary students are impacted by the design of their school. It is clear that the mental and psychological health of students is very dependent on their surroundings and as such the design of their schools should be thoughtful and utilize biophilic patterns.

There are many opportunities for this research to develop and grow in order to better serve students and assess the design of schools more holistically. In addition to the topics covered in this thesis, several other design elements may be explored in relation to how they impact the mental and psychological health of children. One of these elements is play as it is crucial to the healthy development of children. Play is "so important to optimal child development that it has been recognized by the United Nations High Commission for Human Rights as a right of every child." (Ginsburg). Play allows children to develop emotional and cognitive strength, as well as imaginations. It is also shown to help children conquer their fears and become more resilient (Ginsburg). Lastly, children experience great joy when playing which positively impacts their mental health. Many schools already incorporate play into their design, though it would be interesting to explore how play can become a more central component of school design and extend beyond the playground and into the classrooms. Another design element that should be explored in future research is color. Colors have a great impact on mood and perception of the world. The use of color in school design should be intentional and thoughtful as to not have unintended harmful impacts on students.

The literature also conveys a major gap as there is limited information or studies from the perspective of students. While it is crucial to understand the mental impact through social science, it is also important to consider the voices of the people who these spaces are being designed for. Future research should seek out the direct opinion and perspective of children. This information can then be compared to the findings from the existing studies to understand if there are any design elements that have not been considered or have been misrepresented.

In addition, future research can examine how much of a role the structure of the education system has on students' mental and psychological health. Data from schools abroad can be compared to the data presented in this research that focuses on schools in the United States. Schools with similar architecture or design strategies can be compared to understand how much of the impact on students' wellbeing stems from design and how much stems from the structure of the education system, such as the subjects taught, expectations on students, and hours spent in class studying.

Future research should also be extended to consider older and younger children in middle school, high school, and preschool. These children are all at different developmental phases in their lives. As such, the design of their schools might impact them to varying degrees. Also, different design elements may impact some age groups more than others.

In addition to exploring additional age groups, a study should be conducted to understand how socio-economic status impacts school design. Schools may be restricted in how much they can implement biophilic design strategies due to their budget or limited funding. This thesis considered all schools equally and proposed strategies for all schools, regardless of their size, socio-economic status, or other factors that differentiate schools. Further development of design guidelines to create a set of recommendations that are informed by justice, diversity, and social equity.

Lastly, the impacts of schools on the physical health of students can be explored in subsequent research. This will help uncover if the design decisions made for mental health are sufficient for physical health, or if there are additional considerations that designers must make for schools to be healthy places for children.

Aside from future research, it is also important

to explore how the claims and results of this research might be implemented. Many designers and architects already consider the mental health of students when designing a building and as such do not need an incentive to do so. This is not the case in all school designs as there is not a widespread knowledge of the specific and proven ways that architecture impacts children. Also, there are often budget or site restrictions that prevent designers from implementing all of the positive design decisions that can go into elementary schools. This leads to the question of how a culture can be created in which the mental health of students is a primary design consideration and not one that can be easily pushed away. One way to do this may be through city code and incentives. For example, cities might allow additional building height or square footage to schools that significantly incorporate nature into the design. Another way to create this culture might be to include students in the design process. If students are given the opportunity to advise designers on the qualities of a school that make them feel the best, there would be a clearer understanding of what a school that supports the mental wellbeing of children looks and feels like.

Design that considers the mental and psychological wellbeing of children is imperative to creating a healthy, productive, and safe environment for students. There are many ways in which an elementary school can incorporate design elements that support children. A world in which architecture is approached as a social factor with mental and psychological wellbeing at the forefront of design is a more considerate, thoughtful, and supportive place.

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