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Escaping Tradition: An Exploration of Optimized Learning Environments

Mak W. Friery

Undergraduate Interior Design Capstone
College of Art and Design

May 2023

Abstract

This undergraduate interior design capstone research focuses on understanding how forward-thinking design approaches can improve student success and teacher effectiveness in the classroom environment. Addressing the ever-changing needs of students, this research investigates variables of classroom environments such as the impact of color, lighting, acoustics, technology, space planning, furniture, and biophilia. Understanding these factors in the classroom environment can inspire new approaches to design and class flexibility whilst positively impacting student learning outcomes, teacher effectiveness, and overall well-being.

This capstone research is conducted at a time of change within educational design approaches as they continually aim to determine which factors directly enhance learning environments. Outcomes of the anonymous survey and one-to-one interviews pinpoint concerns of current classrooms and standards that can either positively or negatively impact student motivation, engagement, and overall success. Further, case studies centered around flexibility and biophilia provided knowledge to advance interior solutions in response to the issues of the traditional classroom. Providing successful approaches, these studies resulted in significant increases in student engagement, collaboration, happiness, and academic achievements. Analysis of qualitative, data-informed research and ideation provides new approaches and through the lens of flexibility and biophilia.

The Creative Agenda hones in on two key findings from the Literature Review and Research Agenda, biophilia and flexibility, which are proven to aid in student success, teacher effectiveness, and overall well-being. From this, four prototypical classrooms from each pivotal grade level are reimaged to provide insight into designing future-optimized classroom learning environments. The promotion of flexibility through adjustable, moveable furniture and biophilia through access to natural light, views to nature, and material application, drives design decisions. Diagrams, renderings, and additional graphics provide broad ideas for solutions to reimagine classrooms into optimized learning spaces. Moreover, these proposed solutions present future opportunities in K-12 design and answer the research question, How can forward-thinking design approaches improve student success and teacher effectiveness in the classroom environment.

Keywords: Classroom Design, Biophilia, Flexibility, Interior Design, Optimized Learning Environments, Student Engagement, Teacher Effectiveness

Acknowledgements

Throughout the composition of my Undergraduate Interior Design Capstone, I have received a great amount of support and encouragement.

I would like to first thank my Capstone Professor and Committee Chair, Isabella Trindade for her guidance throughout this entire process. Her insightful feedback has pushed me to work at a higher level.

I would also like to express my gratitude to my Committee Member, Brenna Thering for her continuous guidance and insight into educational design. Her perspective and assistance were a tremendous asset throughout my design process.

I would like to also recognize my Committee Member, Wendy Hynes for her continued feedback and knowledge of the educational design field. Additionally, for providing helpful critiques in milestone reviews and introducing me to innovative learning spaces.

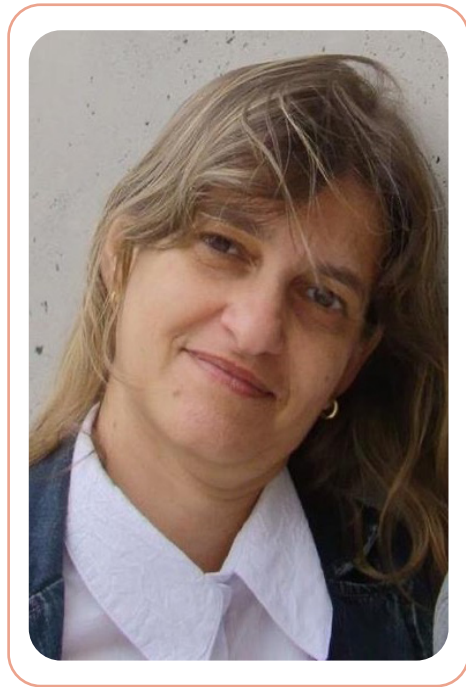
In addition, the support of my parents, family, and friends is unmatched. Thank you for always being a phone call or drive away, and for the laughter and smiles when I needed it most. An incredibly special thank you to my mom, Annette Friery for being the source of my inspiration to always go after what I want. Love you more, most, infinity and beyond, beyond, beyond.

- Mak Friery RIT Interior Design 2023



The Committee

Thank you for your guidance and mentorship throughout my Senior Interior Design Capstone journey. Your expertise and feedback have positively contributed to the comprehension of my topic and seamlessly guided my explorations.



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Literature Review

Introduction

We are aware that children learn in various ways and progress at different rates. Despite this knowledge, most of our schools are still set up for the “sage on the stage” approach which encourages traditional lecture styles of teaching and memorization (Gaspary). This may have been viable in a time when collaboration and critical thinking were unnecessary to be a productive citizen, however, in today’s fast-paced environment these abilities are vital in any industry. To “master” the 21st-century skills of today, the classroom must be changed.

With the onset of the COVID-19 pandemic, we were able to see the ways in which the traditional educational environment falls short. With the heightened recognition of its failures to students and instructors alike, schools have begun to seek solutions that approach learning in an entirely new way. Throwing away the “one-size-fits-all” narrative, K-12 design approaches have started prioritizing student-centered learning, critical thinking development, and interconnectivity. These innovative tactics have redefined the purpose of the classroom and brought about unforeseen opportunities. With the close study of forward-thinking and student-centered design approaches, we can discover what it takes to enhance both student success and teacher effectiveness in the classroom.

Evolution of the Classroom

Prior to the industrial age, the “classroom” was a small, one-room schoolhouse that taught students ranging from 6 to 18 years in age (Miller). This blended method, considered inefficient by today’s standards, was once an effective means of learning. However, at the turn of the 20th century, schools saw a rapid increase in student

enrollment due to new education mandates and laws banning child labor (Brite). In response, schools were treated as “efficient systems” that shaped students into individuals that could contribute to the working world upon graduation. From this, the “factory” model was adopted to maximize floor space with rows of fixed desks and a raised podium in front (Miller). While schoolhouses became a thing of the past, we would continue to see its trends in classroom design for years.

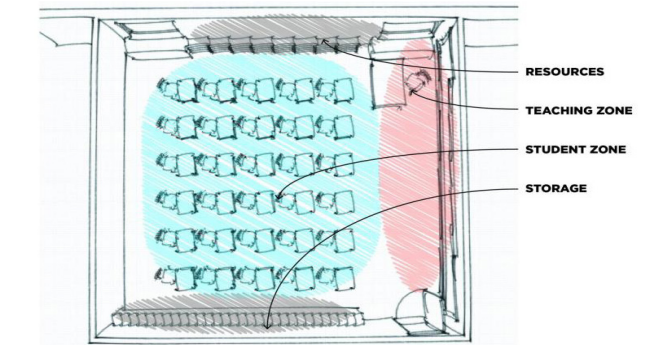


Figure 1: Traditional Classroom Layout (Miller)

Despite the continued use of the factory model, emerging views argued for different approaches to teaching. In fact, as early as the 1880s, theorists began exploring various teaching methods and opportunities within the classroom. It was then that John Dewey introduced progressive education, which emphasized hands-on, experiential learning (AU School of Education). This approach prioritized students’ passions and critical thinking skills to shape them into “lifelong learners” (AU School of Education). While efforts to change teaching techniques persisted, it was not until the mid-1900s that architects and designers began to rethink approaches to classroom design. This can be seen in 1929 when Eliel Saarinen and Richard Neutra joined education reformers to soften the

utilitarian approach from previous decades (Brite). Their collaborative work spawned ideas of daylit rooms and found that students learn and advance better in groups. Regardless of their findings, economic factors took precedence. The new, large windows were enclosed, and concepts of well-being were abandoned.

Nevertheless, classrooms continued to evolve. As technology became more integrated into our everyday lives, it did so in the classroom too. Rooms now gained dedicated spaces for computers, and layouts began to group students to develop team learning skills. That being said, with the introduction of new resources, came the need for a larger footprint.

Today, we find ourselves reimagining the learning environment. We are abandoning traditional practices in pursuit of a greater idea. An idea that education is meant to foster creativity and individuality; and that classrooms must back multiple learning styles, provide security and well-being, promote engagement and collaboration, and most importantly, be student-centered by design. The traditional classroom model must become a thing of the past. It is now time to focus on enhancing students' lives through education and providing spaces that allow schools to do so.

Physical Environment Impact on Student Achievement

On average, American students spend 11,700 hours of their lives in a school building from the time of kindergarten to 12th grade (Cheryan et al.). With growing concern over student engagement and learning, researchers have investigated how the physical

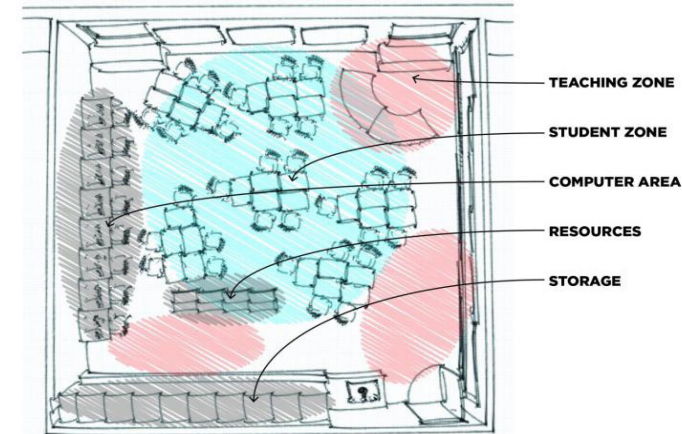


Figure 2: Progressive Classroom Layout (Miller)

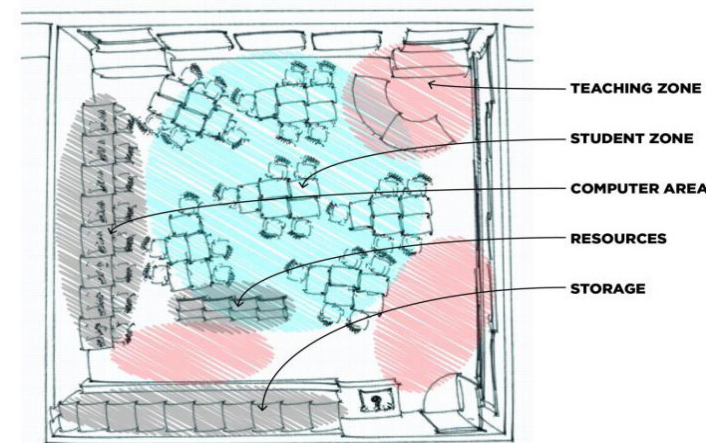


Figure 3: Larger, Resource-based Classroom Layout (Miller)

classroom environment affects students' academic performance. With evidence supporting that both a classroom's structural and symbolic features can either hinder or support achievement, it is more important than ever to identify critical keys of classroom design that improve student success and teacher effectiveness.

The classroom environment has a major impact on the way students learn, therefore it is crucial that teachers and designers strive to create Optimal Learning Environments (OLE). Based on the belief that every student has the ability to achieve high expectations, OLEs prioritize social and emotional elements of learning (New Teacher Center). OLEs are created with three basic concepts in mind: (1) Provide Equitable, Culturally Responsive, and Rigorous Curriculum and Instruction, (2) Create Emotionally, Intellectually, and Physically Safe Environments, and (3) Meet the Diverse Needs of Users. For (1), we must recognize that every child has a different background and perspective to cater to their individual needs. Similarly, (2) focuses on a child's ability to feel supported, safe, and free to express themselves, while (3) looks to maximize the individual strengths of students through the development of multiple learning pathways. Collectively, these foundational factors promise to inform the design of a classroom environment supportive of teacher effectiveness and students' comprehension of lessons and the world itself.

Keys to Optimal Learning Environments

Color

Color visually affects how we perceive our environment and impacts us on various psychological and physiological levels. Nonetheless, color plays a key role in the classroom environment. When utilized effectively it has the capacity to improve visual

processing, reduce stress, and create visual stimulation. However, when used thoughtlessly, it can negatively impact students' attention spans and perception of time (AIA Continuing Education Center). Throughout the mid-1900s, we saw little variation in color as school walls were frequently plastered with neutral greys and browns. Devoid of color, this "soulless" concept failed to eliminate distractions, increasing anxiety, distress, and fear instead. Everything considered, color application must be approached thoughtfully.

Color perceptions are reliant on our cultural backgrounds, age, gender, and geographical location (AIA Continuing Education Center). Therefore, elementary classroom colors drastically vary from those seen in middle and high school settings. Elementary classroom colors look to complement the young students' active, playful, and energized nature. Here the most common preferences are vibrant primary tones of red, orange, yellow, and violet. In contrast, middle and high school students prefer colors that promote concentration and relieve feelings of anxiety. This generally limits vibrant, bright tones in favor of a neutral, cooler palette.

COLOR OBSERVATIONS

The following chart list colors in the spectrum that can be coordinated with a manufacturers color palette.

Red	<p>In general, this color is interpreted as warm or hot. These hues come from the longer wavelengths of the spectrum. Warm colors from this area of the palette include raspberry, strawberry, cherry, watermelon, rouge, geranium, cranberry, maroon, burgundy, wine, ruby and crimson, which have the feeling of advancing toward the viewer.</p> <p>Red:</p> <ul style="list-style-type: none"> • Captures Attention • Considered Passionate • Creates Vitality • Encourages Movement • Generates Excitement <ul style="list-style-type: none"> • Increases Pulse Rate • Promotes Alertness • Prompts Action • Stimulates Appetite • Suggests Strength
Pink	<p>In general, this color is interpreted as warm or hot. These hues come from the longer wavelengths of the spectrum. Colors from this area of the palette include: Pink, rose, magenta, mauve, fuchsia, hot pink, shocking pink, bubblegum, carnation, primrose, petal pink, blush, peony and powder.</p> <p>Pink:</p> <ul style="list-style-type: none"> • Considered Tender • Conveys Delicate Disposition • Expresses Feminine Quality • Implies Innocence <ul style="list-style-type: none"> • Inspires Compassion • Nurtures Affection • Promotes Healthy Impression • Radiates Caring Attitude
Orange	<p>In general this color is interpreted as warm or hot. These hues come from the longer wavelengths of the spectrum. Warm colors from this area of the palette include melon, clay, salmon, coral, peach, apricot, rust, terra-cotta, shrimp, copper, mango, marigold and cinnamon and have the feeling of advancing towards the viewer.</p> <p>Orange:</p> <ul style="list-style-type: none"> • Considered Fun • Encourages Movement • Expresses Emotion • Gregarious Nature • Implies Good Cheer <ul style="list-style-type: none"> • Invites Friendliness • Playful Attitude • Pleasurable Spirit • Suggests Power
Yellow	<p>In general, this color is interpreted as warm or hot. These hues come from the longer wavelengths of the spectrum. Warm colors from this area of the palette include ochre, buttercup, gold, almond, lemon, citrus, honey, brass, amber, sunflower, forsythia, jonquil, daisy and sunshine and have the feeling of advancing toward the viewer.</p> <p>Yellow:</p> <ul style="list-style-type: none"> • Conveys Lightness • Encourages Spontaneity • Expresses Caution • Indicates Innovation • Implies Free Spirit <ul style="list-style-type: none"> • Inspires Creativity • Offers Zest and Joyfulness • Radiates Warmth • Raises Alert Level
Teal	<p>In general, this color is interpreted as cool or cold. These hues come from the shorter wavelengths of the spectrum. Cool colors from this area of the palette include robin's egg, teal, blue-green, aqua, turquoise, sea foam, jade and peacock and have the feeling of receding away from the viewer.</p> <p>Teal:</p> <ul style="list-style-type: none"> • Balanced Appeal • Calming Influence • Conveys Unique Quality • Communicates Gracefulness • Expresses Refinement • Inspires Harmony <ul style="list-style-type: none"> • Nurtures Sensitivity • Refreshing Atmosphere • Renews Spirit • Soothing Demeanor • Suggests Healing

Figure 4: Color Observations (AIA Continuing Education)

Green	<p>In general, this color is interpreted as cool or cold. These hues come from the shorter wavelengths of the spectrum. The greens that are more yellow are considered warmer. Greens that are more blue are considered cooler. Colors from this area of the palette include sage, moss, lime, mint, hunter, celadon, olive, evergreen, leaf, emerald, fern, avocado, grass, spruce, clover and holly and have the feeling of receding away from the viewer.</p> <p>Green:</p> <ul style="list-style-type: none"> • Enhances Concentration • Facilitates Judgment • Nurtures Relaxation • Offers Balance <ul style="list-style-type: none"> • Promotes Security • Provides Refreshing Atmosphere • Renews Spirit • Suggests Healing
Blue	<p>In general, this color is interpreted as cool or cold. These hues come from the shorter wavelengths of the spectrum. Cool colors from this area of the palette include azure, delft, sky, denim, Wedgwood, blueberry, royal, periwinkle, cobalt, ultramarine and navy and have the feeling of receding away from the viewer.</p> <p>Blue:</p> <ul style="list-style-type: none"> • Calming Spirit • Combats Tension • Cultivates Conservatism • Offers Serenity • Promotes Thoughtfulness <ul style="list-style-type: none"> • Provides Introspection • Provides Refreshing Atmosphere • Soothes Nature • Supports Relaxation • Underscores Devotion
Violet	<p>In general, this color is interpreted as cooler. These hues come from the shorter wavelengths of the spectrum. It should be noted that some violets, which are more blue may be considered cooler, while violets which are red will be slightly warmer in feeling. Colors from this area of the palette include iris, amethyst, lilac, orchid, purple, lavender, plum, grape, violet, eggplant and blackberry and generally have the feeling of receding away from us when cool.</p> <p>Violet:</p> <ul style="list-style-type: none"> • Allows Meditation • Contemplative Nature • Conveys Royal Essence • Expresses Mystery • Introspective Persona <ul style="list-style-type: none"> • Intuitive Understanding • Opulent Nature • Sensitive Character • Unique Quality • Whimsical Personality
Warm Neutrals	<p>WARM NEUTRALS Warm hues are the subdued tones that come from the longer wavelengths of the spectrum. These colors include khaki, oatmeal, bisque, chocolate, tea, desert, toast, mahogany, cream, straw, vanilla, off-white, tan, taupe, beige, ivory, oyster, pearl, sand, bronze and brown and have the feeling of subtly advancing toward the viewer.</p> <p>Warm Neutrals:</p> <ul style="list-style-type: none"> • Comfortable Attitude • Conservative Nature • Implies Stability • Communicates Gracefulness <ul style="list-style-type: none"> • Promotes Secure Feeling • Suggests Subtle Warmth • Versatile Nature
Cool Neutrals	<p>In general, this color area is interpreted as cool. These hues include colors of fog, ebony, stainless, pewter, smoke, ash, chrome, white, frost, grey, charcoal, slate, graphite, onyx, silver & stone & have the feeling of subtly receding away from the viewer.</p> <p>Cool Neutrals:</p> <ul style="list-style-type: none"> • Implies Sophistication • Introspective Nature • Soothing Atmosphere <ul style="list-style-type: none"> • Subdues Emotional Response • Suggests Subtle Coolness • Versatile Nature

Lighting

“Used properly, color and light can provide an atmosphere conducive to learning” (AIA Continuing Education Center). Lighting may not be one's first thought when designing a classroom, however, research suggests that the color of light is significant to student performance and productivity. While good lighting conditions can promote children's eyesight development, create comfortable spaces, and improve student efficiency, bad lighting can do just the opposite. Though it may go unnoticed, lighting quality can also impact how humans feel. Lighting that is too dim, or flickering can cause students and teachers to lose focus and feel drowsy (TCPi). Adversely, bright, or natural light helps in keeping them alert and awake (TCPi).

Schools have relied heavily on fluorescent lights to illuminate the classroom for decades. Though the most efficient and affordable option at one time, research has revealed that their poor quality negatively contributes to student performance and teacher effectiveness (TCPi). Their slight flicker and dimmed quality are not only distracting but are thought to be the cause of increased eye strain, headaches, and discomfort (TCPi). Moreover, with their increasing negative reputation, schools and designers have sought out alternative lighting systems.

Today, LEDs promise to be the most efficient, recyclable, long-lasting and flexible light source. Their capacity to produce a brighter, cooler illumination imitates natural light and aids in producing a comfortable atmosphere. This enables students to be more attentive and teachers to be more alert (TCPi). LED lights are also great for classroom settings that require flexibility, as they incorporate different light outputs and color temperatures.

Additionally, LEDs are more supportive of health. Excluding the harmful contaminants that older fluorescents contain, they are proven to be beneficial for vision and even mental well-being (TCPi). In all, LED lighting can greatly improve academic achievement and behavior in the classroom. Regardless of their upfront cost, investments are sure to pay off through lower energy bills, longer lifespans, and most importantly performance.

Acoustics

Because teaching and learning are acoustically demanding activities, noise within the classroom and school building itself can massively interfere with learning. Though the source of noise varies, they typically involve loud air-conditioners, or HVAC, peers in the hallways, and even road traffic (Cheryan et al.). These internal and external disruptions hinder learning for all students, especially those with hearing difficulties, behavioral issues, learning disabilities, and attention problems (Cheryan et al.).

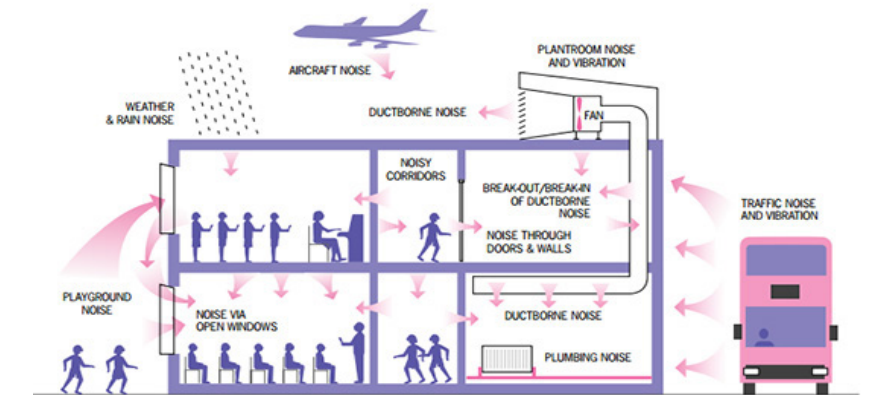


Figure 5: Classroom Noise Sources (Resonics)

Literature Review

Fortunately, there are methods to combat acoustical issues in the classroom. The most common strategies include the limitation of hard surfaces, implementation of carpet tiles or rugs, and use of acoustical ceiling tiles (ACT), suspended baffles, or acoustic wall panels. Approaching acoustics as an afterthought is detrimental to students and staff alike. Nevertheless, acoustically treated environments provide a healthier and happier classroom that supports concentration, well-being, and achievement.

Technology

In today's age, technology is embedded within every aspect of our lives. Correspondingly, schools raced to incorporate technology in classroom environments. In education, technology allows students and teachers to learn in ways like never before. According to Johnson, if used correctly, technology can “invoke dream in the minds of visionary educators who saw endless potential for altering traditional notions of teaching and learning” (p. 2). The utilization of technology within the classroom contributes to increased academic achievement, student engagement, and motivation (Reese, p. 14-19). Additionally, classroom implementation has seen positive outcomes especially when it comes to literacy skills and reading scores (Reese, p. 8-10). With the capacity to accommodate various learning styles and be a resource separate from textbooks and worksheets, technology has given us the opportunity to expand the range and quality of teaching content.

Technology can be incorporated within the design of the classroom in various ways. Common applications include computer docking and printing stations, interactive whiteboards, and even huddle spaces. With immediate access to information, interactive whiteboards provide an opportunity for student engagement

through interactive lessons and games. Additionally, huddle or tech-based spaces feature interactive displays that promote collaboration between students and teachers. With its integration into the built environment and instruction, technology can help engage students, build relationships between teachers and students, cater to various learning styles, and ultimately prepare students with skills needed for the future. While traditional classrooms and methods left students as passive participants, technology gives students the opportunity to directly engage with the material they are learning.

Space Planning and Layouts

The way a classroom is laid out can greatly impact teacher effectiveness and student learning. In fact, furniture arrangement can influence students' comfort levels and even interactions with others (Cheryan et al.). The most common classroom layouts include traditional rows, paired desks, horseshoes, and clustered arrangements. Used interchangeably and in combination, these “guidelines” described below offer alternative layout options that come with their own advantages and disadvantages. Nevertheless, approaches to classroom arrangements must prioritize flexibility, and be dependent on specific learning goals and activities of the class.

The traditional layout of rows is the most common classroom arrangement which revolves around on-task behavior, independent tasks, and teacher-based instruction (Rogers, p.32). While it has been around for centuries, this model discourages student-centered discussions, collaboration, and engagement. Additionally, this seating arrangement has been shown to produce uneven levels of interaction and concentration between the front

and back of the classroom.

Closely associated with the traditional classroom layout, the paired desk model provides a more flexible option that promotes on-task behavior, focus, and participation (Rogers, p. 32). As its name suggests, this layout arranges students' desks into groups of two. Ideal for class and group discussions, this seating option allows students to learn from one another and work independently.

The U-shape, or horseshoe layout consists of desks arranged in a semi-circle around the classroom. With everyone facing their peers and the teacher, this layout has proven to increase collaboration, communication, engagement, and participation. With these benefits, researchers have found it to be the most effective for classroom learning and academic success (Rogers, p.39-41). However, this is not to say it is effective for all classrooms as it does not support independent tasks or small-group work. Ultimately, the horseshoe layout works best in classrooms that emphasize group discussion and prioritize student relationships.

Unlike the horseshoe layout, the cluster model is great for small-group discussion, social interaction, and collaboration (Rogers, p.32). Given more responsibility and opportunities to learn from peers, this layout arranges students into groups of four around the classroom. Though not the best option for minimized distractions or independent work, clusters provide a safer, more comfortable learning environment for students to share ideas and problem-solve.

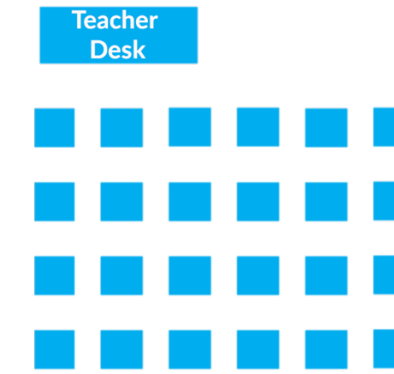


Figure 6: Rows/Grid Layout (Renard)

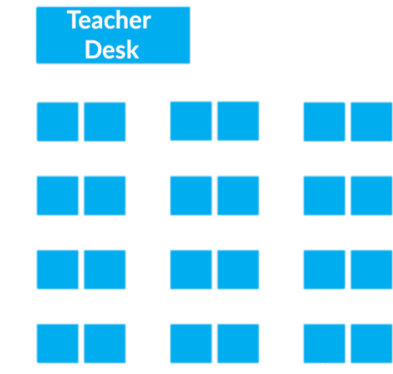


Figure 7: Pairs Layout (Renard)

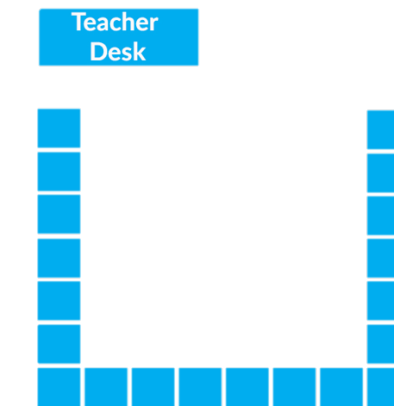


Figure 8: Horseshoe Layout (Renard)

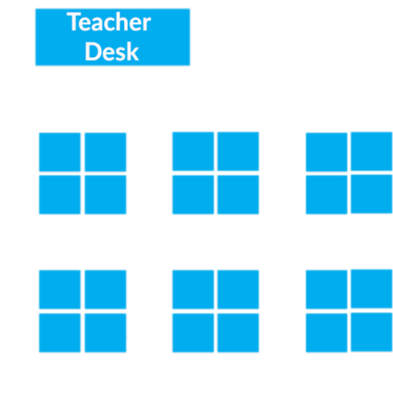


Figure 9: Cluster Layout (Renard)

Furniture

The impact school classroom furniture has on learning and teaching is undeniable. As students' interaction with furniture surpasses the use of all other design elements, its role in creating an optimal learning environment is crucial. However, as no student is built the same as the next, investing in purposeful furniture that accommodates mobility, adjustability, size, and comfort is key to the long-term adaptability of the space.

Furniture mobility offers opportunities to move around faster and rearrange the classroom in different settings. This supports various instructional methods and even facilitates interpersonal communication and collaboration between students and teachers (Rands & Gansemer-Topf). Although, the mobility of classroom furniture entails not only the ability to move it around the room but also the ability for students to move in it. Traditional classroom chairs require students to sit still, disregarding their innate nature to fidget and move around. However, with studies indicating that micromovement has been shown to reduce anxiety, enhance concentration, and help with excess energy, furniture ergonomics have begun to implement movement (MooreCo, p. 19). With the inclusion of features that enable movement like rocking, swiveling, and even bouncing, students can find new comfort in their environment.

Adjustable furniture is also crucial for student comfort and classroom performance. Therefore, sit-to-stand and height-adjustable options are great to accommodate an extensive range of individuals. Additionally, these features provide necessary physical activity and movement within the learning environment which significantly improves students' learning, memory retention, and exam

outcomes (MooreCo).

Physical requirements like size and scale are also important to account for. In reality, up to 83% of elementary students are sitting in desks and chairs that are sized incorrectly (MooreCo, p. 21). This not only leads to unnecessary discomfort but also an unintentional distraction from instruction and tasks. Moreover, with seating and desks scaled to fit the size of students, distractions from pain and discomfort can become a thing of the past.

The furniture of today challenges the preconceived notion that children cannot learn when comfortable. In fact, ergonomic comfort has just the opposite impact as it enables students to focus on the task at hand rather than the distraction of pain and restlessness. Additionally, with the addition of comfortable seating choices, students are provided with a variety of options that allow them to relax, focus, and engage on their own terms.

Biophilia

Biophilia, a Greek term that originated from the words "bios," meaning life or living, and "philia," love or fondness, was first introduced in the 1980s by American biologist and Harvard Professor Edward O. Wilson as the innate attraction humans feel toward nature (Basdogan). As an evolution of that concept, biophilic design is the approach of implementing elements of nature into the built environment to positively impact human well-being (Basdogan). According to Terrapin Bright Green, a leader in the sustainability industry, we see the key biophilic design principles falling into three core categories: Nature in Space, Natural Analogues, and Nature of the Space. Nature in the Space incorporates real, physical elements of nature into environments.

This includes anything from natural sunlight with the use of windows and skylights to indoor water fixtures and even green walls. In practice, these applications were found to benefit appetite, digestive health, mood balance, and overall well-being (Gower). Differently, Natural Analogues involve the incorporation of literal and implied representations of nature into the physical space. This involves the use of shapes, patterns, and colors that are reminiscent of nature, or even natural material applications with wood and stone. These applications were found to not only combat stress, but also inspire curiosity, imagination, and discovery in students (Gower). Nature of the Space focuses on the relationship of humans to the design of the physical space. Examples include sight lines, places of refuge, and the overall flow of the space. These elements offer students the opportunity to separate themselves from noise, distractions, and other people which is vital in reducing a child's stress. In all, due to findings that show its positive impact on well-being, biophilia has become a front-running trend in healthcare, hospitality, and corporate industries. Just beginning to see its prevalence in K-12 environments, we begin to discover biophilia's role in today's educational environment.

The idea that spending time in nature positively impacts one's mental and physical health isn't a new one. With today's students spending less time outdoors than ever before, we have begun seeking opportunities to bridge the gap between the classroom and nature. Though some may question the importance of biophilia in the classroom, ongoing research indicates that infusing learning environments with elements of nature has a plethora of benefits. Some widespread observations include increased student engagement, attendance, productivity, happiness, and even improved behavior (Basdogan). In fact, studies dating back

to the 1990s demonstrated a strong connection between natural daylight and higher test scores, and more recent studies found a beneficial association between exposure to green space and cognitive development amongst elementary-aged students (Gower). Ultimately, when comparing traditional classrooms to biophilic learning spaces, they have concluded it has had an inarguable impact on student success. These studies have shown that "optimizing exposure to daylight alone can improve school attendance by an average of 3.5 days/year and test scores by 5-14% whilst increasing the speed of learning by 20-26%" and that "plants in classrooms can lead to improved performance in spelling, mathematics, and science of 10-14%" (Gower). Not only has research found biophilic applications to increase success, but also that they increase overall mood. As the American Society for Horticultural Science found, "the students in the class with plants rated both their course and their lecturer more favorably" (Basgodan). All in all, biophilia is an important tool that presents an opportunity for schools to enhance student outcomes and teacher performance.

Limitations

In spite of ongoing research and various solutions to increase student success and teacher effectiveness within the classroom environment, there are still limitations to be recognized. In fact, teachers' "buy-in" and adoption is the largest determining factor in the success of new classroom designs. Though out of the design scope, professional development is needed to show teachers how to effectively use the resources given to them and maximize the benefits of their new environment. Changes to longstanding traditions come with their struggles. Learning side by side, these "old dogs" can learn new tricks and be incentivized to change the

dynamic of their classroom. Additionally, there are limitations within school budgets. These changes are often costly, leaving those in low-income areas disproportionately affected. Moreover, with no all-encompassing solution to classroom design, we must overcome obstacles.

Literature Review Conclusions

In conclusion, there are many variables to be considered when designing optimal classroom learning environments conducive to student success and teacher effectiveness. The main factors to acknowledge when approaching classroom design include color, lighting, acoustics, technology, space planning, furniture, and biophilia. However, it is especially important to recognize that there is not a “one-size-fits-all” answer. Instead, it is about approaching classroom design in a way that meets the ever-changing needs of students. This requires a broad range of approaches, tools, and spaces that allow the built environment to address student and teacher needs. As Murrphy (3) said it best,

“...no environment perfectly meets the wide range of needs we experience daily in our schools. We all must problem-solve to overcome limitations and create the teaching and learning environments required at the time. However, greater flexibility in architecture and the ways we think about space and flexible pedagogical approaches do assist schools' ability to do this.”

Research Agenda

Introduction

The methods used for the Research Agenda consisting of qualitative data were collected through a multi-prompt approach focused on several variables of classroom design to defend the thesis question, “How can forward-thinking, flexible design approaches improve student success and teacher effectiveness in the classroom environment?”. Variables include the impact of color, lighting, acoustics, technology, space planning, furniture, and biophilia. Collected using surveys, interviews, and analysis of case studies, these instruments aid in an increased comprehension of the design elements needed to inform design thinking and the Creative Agenda of this thesis proposal. Surveys and interviews were conducted with various teachers of all ages and subjects. Additionally, case studies focused on student-centered design, flexibility, and biophilic approaches to enhance teacher effectiveness and student success in classroom learning environments were conducted to support other research methods.

A survey conducted with those currently in the education field aids in identifying concerns with traditional classroom design concepts and models as they exclude student-centered learning, flexibility, and concepts of well-being. The surveys were sent out in emails after gaining permission from school principals and some were sent directly to people to receive a multitude of responses in return. This project is addressing the public school workforce, therefore to gather accurate and honest data, surveys remained anonymous unless the instructors were willing to give their contact information for further one-on-one interviews about their experiences.

Included in the Research Agenda, interviews with teachers in the education field provided opportunities to gain their first-hand

first-hand perspectives, experiences, and suggestions pertaining to the design of learning environments. Providing critical observations of their experience teaching within their classroom, this interview allowed for a greater understanding of classroom dynamics and how its design can support both students and teachers.

Case studies were beneficial as they provided successful approaches to classroom design in the lens of flexibility and biophilia. While being able to examine solutions to stressors and perceptions of classroom learning environments, we can get an insight into what directly improves overall academic success and the effectiveness of teachers.

A comparative analysis for the Literature Review validates that emerging trends of forward-thinking, student-centered, and flexible design approaches have a positive impact on student success and teacher effectiveness within the classroom environment. The Literature Review summarizes previous analytical research on the focused variables that have been chosen for the thesis proposal. Overall, quantitative and qualitative research conducted through case studies, surveys, and one-on-one interviews with experts in the field, supports the goals and intentions of the Research Agenda and supports Literature Review findings.

Research Agenda Findings

Survey Data Collection

An online survey was released on November 4, 2022, through emails with school principals and teachers to reach various demographics and individuals who have experience in classroom environments (Appendix B). Survey questions were based on adaptations to the design of classroom environments to combat major concerns.

In total, 47 individuals took the survey and thoughtfully answered multiple-choice and open-ended questions. Respondents acknowledged their experience within various classroom environments regarding instruction, student behavior, and teaching tools. The goal of this survey was to discover existing problems and concerns within traditional classrooms, which then could drive more research and design decisions, to promote and discover ways to improve classroom learning environments with a focus on flexibility and biophilia.

What are the major issues you face within your current classroom?

Question one summary: Overall, respondents found issues with space, lighting, acoustics, temperature, furniture, technology, and finishes. Many classrooms lack adequate space for circulation and often do not allow for any display of student work. Lighting was also found to be an issue as fluorescents are often too bright and harsh. Additionally outdated technology, acoustical issues, and temperature seem to negatively impact students and teachers. The most prevalent problem was found within classroom furniture. The lack of updated seating and tables has made it nearly impossible to switch up arrangements quickly and effectively and was even found to intrude on their individual work with students. As the Literature Review supports, flexibility in furniture is vital to student success and teacher effectiveness.

Do you find it difficult to engage students?

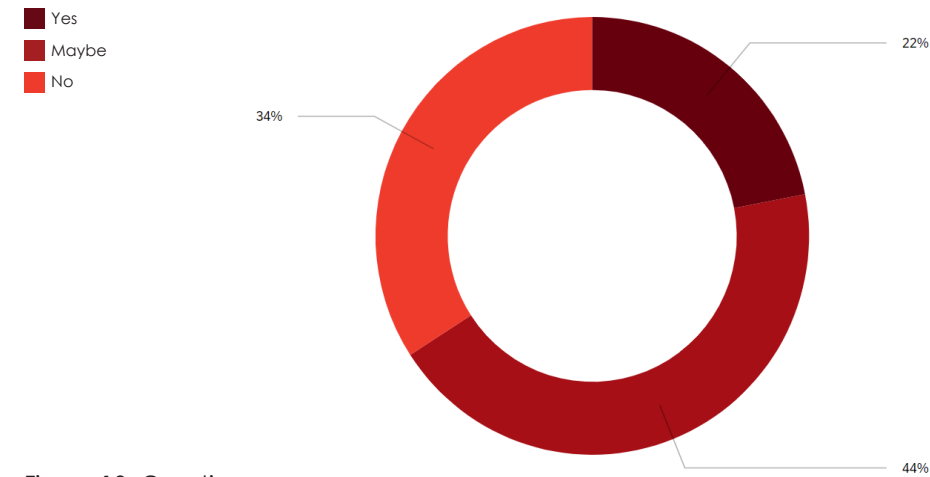


Figure 10: Question one

Question two summary: There were some mixed results from this question. While some said they have always had great success with engaging their students in learning, it was found that others struggle with student engagement due to phones, behavioral issues, and interest levels. Interestingly, those that found success utilized technology with video, pictures, and movement and were also good with student-teacher relationship building. Having a space for student-teacher building and de-escalation is important for overall student interest and engagement in learning material. It was also found that age also plays a role in engagement. Those at younger grade levels tend to be easily distracted by their environment. Overall, it seems that engagement comes down to many variables including student interest levels, student-teacher relationships, district standardization, and social-emotional needs.

Do you find that lighting impacts student engagement?

Question three summary: Overall, 58% of the survey members found that lighting impacts student engagement while 29% believe that it may have an impact, and 13% believe it does not. This concludes that lighting has been shown to either positively or negatively affect student engagement levels in the classroom environment.

What seems to be the most ideal lighting? (warm, cool, some lights on and off, prefer natural light)

Question four summary: Overall, most respondents preferred either natural light (all lights off) or some lights on and others off. Additional answers included preferences for dimming controls, lamps, glow, and strip lights. Interestingly, one response concluded that they like the temperature of their lighting based on the season; meaning they favor cool lighting in the spring/summer and warm lighting in the fall/winter. There were also concerns about their existing fluorescent lights as they are far too intense, flickering, and at times, loud. Overall, findings indicate that lighting controls are necessary to give teachers and students options that suit classroom activities.

Which of the following do you believe would increase student engagement?

- Height-adjustable furniture
- Adequate artificial lighting
- Acoustic/Noise controls
- Temperature

Question five summary: This question brought about some mixed results. 30% of survey members believe that temperature plays the largest role in student engagement, while 28% think height-adjustable furniture does. These results correlate with the research findings. While all factors and/or features play a role in student engagement levels, it seems that some take precedence over others.

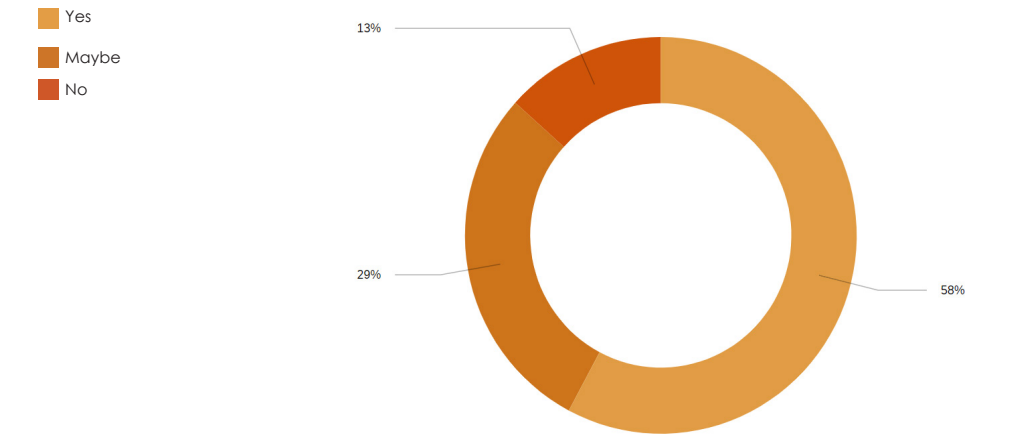


Figure 11: Question three

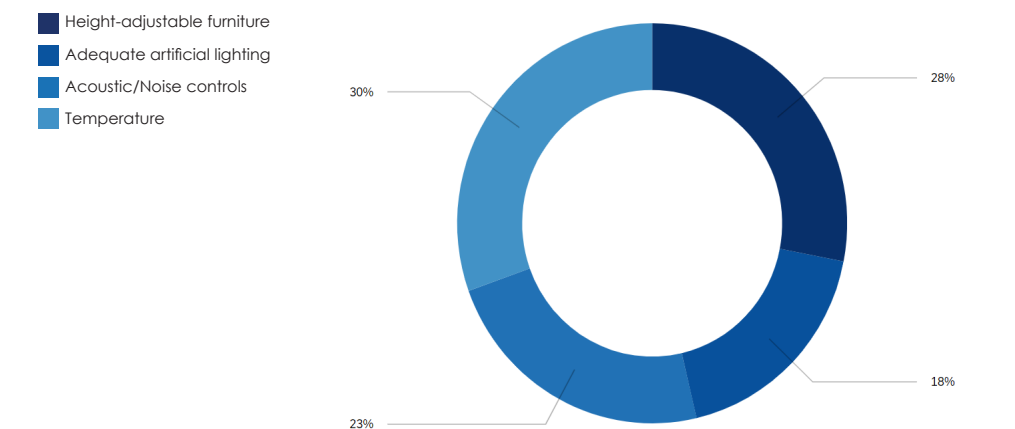


Figure 12: Question four

Out of the following, which do you think is most important in improving the classroom environment?

- a. More storage
- b. More soft/comfortable seating options
- c. Better lighting
- d. Bigger classrooms
- e. Moveable furniture
- f. Other

Question six summary: Data collected indicates that the most important aspects to be thoughtful of include more comfortable and soft seating, bigger classrooms, and moveable furniture. However, results also suggest that all the options are of importance in the success of classroom designs. Survey members who responded “other” mentioned updated technology, access to electrical circuits to support technology, modernized rooms, as well as the importance of closed-in rooms compared to open classrooms. This collection of data will greatly impact future design decisions and supports concepts of flexibility and modern design approaches.

Do you think the addition of biophilia (elements that connect you to nature) in the classroom would enhance the students' and your own experience?

For example: Living Walls, skylights, visuals of nature, indoor plants, natural colors.

Question seven summary: Data collected shows that 91% of the respondents think biophilia would enhance student and teacher experiences in the classroom. Those that responded “yes” believe it can create a calming, personable, comfortable environment that aids mental well-being. Overwhelmingly, respondents believe

that a nature-inspired environment can promote student confidence and overall success. However, implementation is highly dependent on cost and the school budget. Design decisions should factor in viable options that consider budget and stimulation.

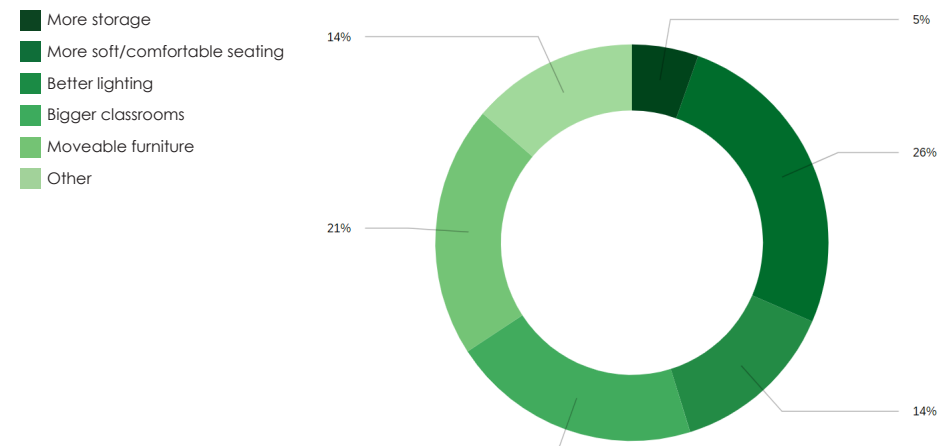


Figure 13: Question six

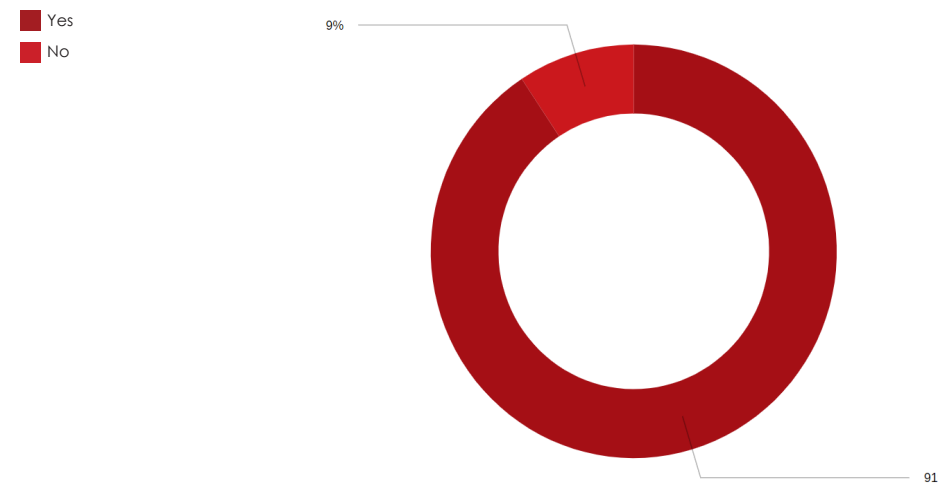


Figure 14: Question seven

Would you prefer a stationary or movable desk on casters?

Question eight summary: Overall, the chart shows a generally split decision. Those that preferred mobile desks like the ease of shifting the classroom to accommodate for the needs of the lesson. On the other hand, those that preferred stationary desks liked having their own designated space and favored a more controlled, structured environment. Additionally, there was a preference for sit-stand options that allowed for flexibility depending on classroom activities. Though teachers had differing opinions on desk preferences, their answers reflect a need for flexibility with a desk that gives them a choice of how to work and several features that support them.

Is your current classroom suitable for hybrid (online and in-person) learning?

Question nine summary: 52% of survey respondents found that their current classrooms are properly equipped for hybrid learning while 20% thought they may be, and 27% indicated that they were not. This concludes that while some classrooms have adapted to post-covid hybrid/remote learning, others lack accommodations due to outdated technology and equipment.

What do you feel is needed in the classroom to support hybrid learning?

Question ten summary: When asked what was needed to support hybrid/remote learning within the classroom, teachers emphasized the need for better, reliable equipment such as cameras, microphones, laptops, smart boards, outlets, and movable tech stations. From this, respondents also acknowledged that hybrid

learning takes away from the individual contact they have in a classroom setting, creates distractions, and is often not an effective method of teaching. Correspondingly, hybrid learning is especially difficult for those in younger grade levels. Nonetheless, having the necessary equipment to support classroom instruction both within and outside of the environment itself is important for adapting to the ever-changing needs of students and their safety.

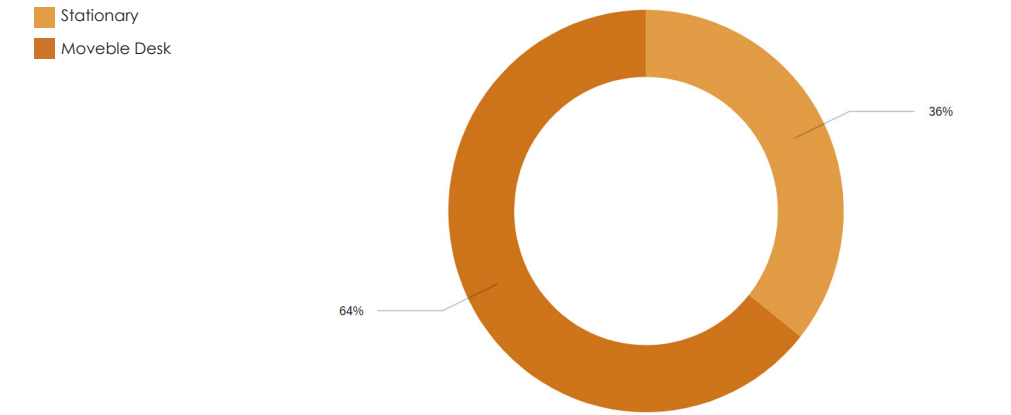


Figure 15: Question eight

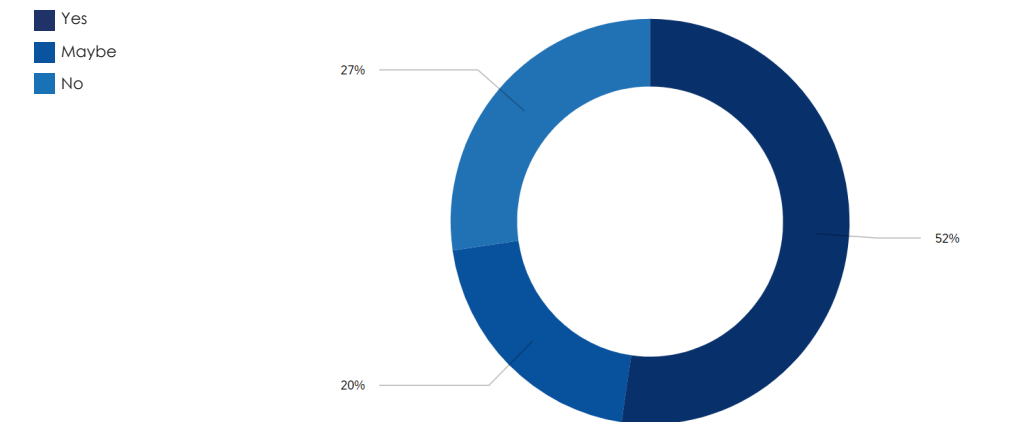


Figure 16: Question nine

What changes do you think would optimize the classroom experience?

Question eleven summary: Out of the responses, furniture was the most prevalent factor believed to optimize the classroom experience. There is a priority for flexible and ergonomically comfortable furniture that can be adjusted to meet the needs of the lesson, whether it be group work, independent tasks, or talking circles. As indicated in other answers as well, there is a need for more space, better acoustics, updated paint colors, new technology, controlled temperatures, and personalized teacher spaces within classrooms. These considerations inform the Creative Agenda and design decisions to improve and optimize classroom environments.

If there was one thing you could choose to have in your classroom (without a budget in mind), what would it be?

Question twelve summary: This question is meant to gauge what teachers want most within their classroom, regardless of school budget concerns. Various responses included that they would like to have workstations or centers for targeted learning, multiple interactive technology displays rather than a central smart board, a variety of seating options including standing and lap desks, soft tone colors, soft seating corners that support de-escalation and socio-emotional needs, as well as bookcases and storage for classroom materials.

Survey Conclusions

Using this survey as a research tool provided the opportunity to gain knowledge about teachers' opinions and experiences within their classrooms. Findings supported the hypothesis concerns that

the traditional classroom model negatively impacts students and teachers alike in relation to student success and teacher effectiveness. With knowledge about identified concerns, these findings influence the Creative Agenda for prototypical classroom experiences that emphasize flexibility, engagement, and mental well-being.

One to One Interviews

One-to-one interviews were conducted with volunteers that participated in the online survey about their experiences teaching in both traditional and modern classrooms. Interviews included various questions based on student engagement, furniture, and other factors to gain an understanding of typical classroom environments. Full documentation of these interview questions can be found in Appendix C. One interview was completed with an instructor who had only experienced a traditional classroom while two additional interviews were with teachers who have just recently had furniture and building updates. Targeting these individuals gave an insight into how their new environments have impacted classroom dynamics and student learning outcomes. Similar to the online survey, these interviews were to further research and discover the perspectives and concerns of teachers, to better understand what increases student success and teacher effectiveness in classroom environments.

Interviewee 01: Social Studies, Grades 6-12, 7 years of experience

Interviewee 02: Spanish, Grades 9-12, 28 years of experience

Interviewee 03: General Education teacher, 1st grade, 12 years of experience

Traditional Classroom

Interviewee 01 currently teaches within a traditional classroom environment. Consisting of large, outdated desks, this room was found to have many issues that are a detriment to student success. From poor lighting conditions to circulation, this classroom hinders student motivation and lacks proper equipment to support teacher effectiveness. When discussing what it would take to optimize the classroom, there was a focus on furniture and lighting. As mentioned, their current furniture is immobile, wooden, and extremely uncomfortable. There is a need for adjustable and standing desks that support movement and fidgeting for those that cannot sit still when learning. Additionally, they mentioned how flexibility where learning happens is vital to the student's success. This means that easily movable furniture is key to classroom dynamics. Keeping students engaged through different classroom arrangements and movement is what they believe is best for optimized experiences. Further discussions were about lighting, which has been shown to either positively or negatively impact student mood and engagement. Natural light seems to be the best option, however, adjustable shades and dimming lights were highly suggested as they give teachers an "upper hand". Overall, the responses reiterated the need for flexibility. Mainly concerning furniture, flexibility is needed to meet all students' needs.

Updated Furniture

Interviewee 02 is currently teaching in a room that has been given a variety of flexible furniture options within the past year. Being in their room for over 28 years, this teacher has seen a difference overall since the change to new seating. Given three new types – standing desks, regular-height tables, and single student desks, this teacher has seen improvements in student interaction and even

engagement. The standing desks are appropriate for those that have a hard time sitting for long lengths of time, while the regular height tables are customized with a whiteboard top surface which comes in handy for many classroom activities. Additionally, the single-student desks are great for moving around and are collaborative to support group work. From these, they have noticed a more engaging atmosphere that promotes discussion. On top of the new student furniture, this teacher was also given a mobile, height-adjustable desk unit. So far, they are "loving it" as it enables them to have their laptop at all times, and move around the room with ease. Continuing, we spoke about biophilia and viable options within classrooms. In support of the idea, Interviewee 02 believed it would have a great calming effect that makes the room more comfortable and inviting to everyone. Speaking on their own experiences, students have such a different mood and energy level when there is a lack of natural light. In the mention of lighting, this teacher saw its major impact on student engagement. Though natural light is preferred, that is not always an option, especially in the winter. Therefore, the lights within the room must support students. This teacher's existing fluorescents are often too bright and have been the cause of chronic headaches. Therefore, lighting is vital for student success and must be controllable for the teacher. Lastly, we spoke about, if anything, what this teacher would want to have in their classroom without a budget in mind. Their first response was a bigger room. Despite the positive impact of new furniture pieces, circulation within the room is difficult and often crowded. Having more space would be beneficial, and provide opportunities for more stations, and even a comfortable seating area for independent reading and other tasks.

Updated Furniture and Finishes

Interviewee 03 is currently teaching within a modern, updated classroom environment. Since teaching in this new classroom, they have seen a big change in student engagement levels and overall flexibility in students' learning. They credit this to their new flexible seating options that allow students to choose which items are best for them to be successful. Additionally, this variety has allowed the teacher to adjust easily to meet all students' needs. Interviewee 03 was also asked about the mobility of their own desk. Their response suggested that a mobile desk would be great for interaction with students at any spot in the room and that it would also aid with classroom rearrangements. Further, Interviewee 03 was asked about other classroom factors including biophilia, lighting, color, technology, and acoustics. When discussing biophilia in the classroom, the answers were very similar to the previous interviews as they thought indoor plants, expansive windows, and natural, relaxing paint colors would be viable options. We also had a discussion on student engagement levels in relation to lighting. Reiterating previous answers, natural light seems to be the most effective in engaging students. Additionally, they stated that lamp lighting, window shading capabilities, and dimming controls would aid in creating a more optimized environment. Technology was also found to increase student engagement levels and is embedded within instruction and activities in their classroom. One thing that interested Interviewee 03 was the mobile interactive displays and dedicated tech spaces. However, given the lack of adequate space, this is an unlikely opportunity for their classroom. In all, Interviewee 03 has seen great success since the increased flexibility of their classroom. The variety of seating options has given students new opportunities and increased their motivation to succeed. Overall, flexible furniture has proven to optimize the

classroom experience and enhance student learning.

Case Studies

The chosen case studies focus on the topics of increased student success and teacher effectiveness in relation to the key topics of flexibility and biophilia. Identifying what applications result in the highest levels of student success, learning outcomes, and teacher impact has validated their positive impact in classroom environments. Providing valuable information on functional concepts of flexibility and biophilia in learning environments, these studies are critical to this thesis design proposal.

Case Study 01: Elementary School, Southwestern United States

A research study took place at a public elementary school in the Southwestern United States to assess the impact of flexible furniture on student movement, choice, and perception of the learning environment. Breaking it down, four classrooms rated as "highly flexible" were compared to six classrooms identified as having no or low flexibility. The first research question, involving student perceptions of their learning environment, indicated that those in the flexible classrooms had higher average ratings of satisfaction. Supportive of earlier Literature Review findings, this data indicates that flexible furniture has the potential to create learning environments influential to students' perception of their classroom, and even their overall feelings toward school. Correspondingly, these flexible rooms were found to be more comfortable, which allowed for increased attentiveness and higher levels of enjoyment among students. Additional observations involving student movement and autonomy were discussed. Those with flexible furniture had many opportunities for movement without reprimand or potential consequences. With this freedom, students were given

more opportunities to take ownership of their environment through the choice of where they worked best. In giving these students the ability to discover which seats and workspaces accommodate their learning needs and comfort levels, they observed improved student engagement and enthusiasm toward learning.

In all, flexible classrooms have the potential to create more effective learning environments that improve student perceptions, choice, movement, and active learning (Attai et al.). Promoting flexible learning spaces is vital to breaking the rigidity of traditional classrooms and giving students the opportunity of choice and ownership over their learning. The ultimate takeaway is that when flexibility in furniture and classroom dynamics is combined with physical environment factors, there is a great impact on student achievement. When used effectively, flexible classrooms can increase student engagement, which correspondingly produces better academic outcomes among school students than the traditional, static classroom designs.

Case Study 02: Green Street Academy, Baltimore

An experiment located at Green Street Academy in Baltimore looked to analyze the impact of biophilic design on student outcomes. Focused on several effects – stress, perceptions of the learning environment, enjoyment, and math academic performance, this classroom utilized three biophilic design devices to enhance the existing room. The first device, views to nature, was accomplished through the planting of a garden outside the classroom windows. Filled with a variety of evergreen and deciduous plants, the garden looked to attract birds, butterflies, and insects to serve as a short break from focused attention on schoolwork. The second device, dynamic and diffused lighting



Figure 17: Traditional Learning Environment (Attai et al.)

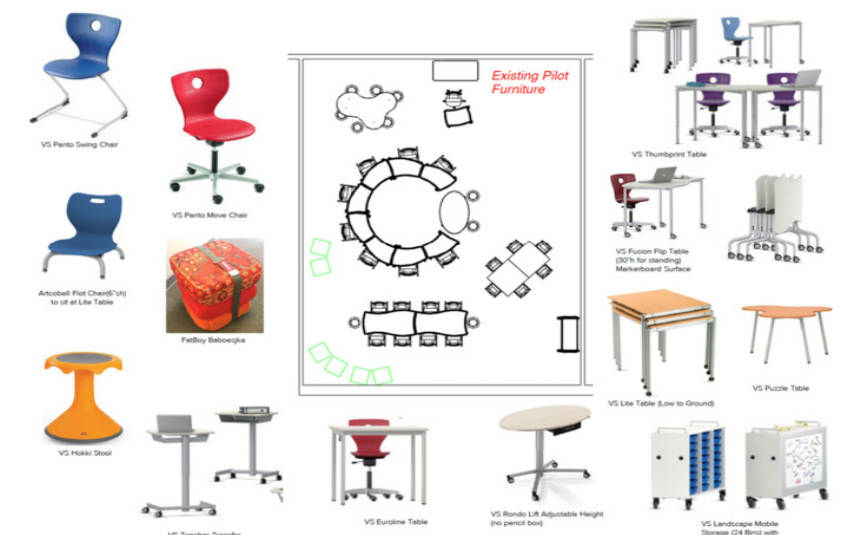


Figure 18: Flexible Learning Environment (Attai et al.)

was explored with the implementation of motorized, perforated, translucent roller shades operated by a solar cell. Replacing the opaque “mini blinds”, these shades automatically raise and lower according to sunlight levels on the window. Also imprinted with the image of tree shadows, this shade provides diffused daylight which supports visual comfort and has been associated with positive impacts on circadian rhythm functioning (Determan et al., p. 8). The final device, biomorphic forms, was provided through nature-inspired patterns located on several classroom surfaces. From wall graphics to carpeting and 3-dimensional acoustical ceiling tiles, this classroom offered abstract interpretations of prairie grass, trees, and ocean waves.

To determine the impact of these biophilic devices, a control classroom was utilized to validate findings. To measure stress, students gave opinions about their own stress levels in both the biophilic and control classrooms. In the beginning, results showed that 67 percent of students in the biophilic environment perceived their stressors to be high compared to 56 percent in the control classroom. However, the end-of-semester results indicated that 35 percent of those in the biophilic classroom perceived their stressors to be high compared to 67 percent of the students in the other. Moreover, these findings suggest that the biophilic classroom aided in reducing students' stress levels during the semester to a greater extent than the control classroom. Further examinations determined that students in the biophilic classroom experienced higher levels of enjoyment in lessons, increased levels of participation, improved learning outcomes, and even better perceptions of the physical space. Overall, these studies have shown that biophilic learning environments contribute to less anxiety, improved attentiveness and cognition, positive attitudes, reduced student stress, and enhanced learning outcomes.



Figure 19: Garden (Determan et al.)



Figure 20: Shades (Determan et al.)



Figure 21: Carpet (Determan et al.)



Figure 22: Patterns (Determan et al.)



Figure 23: Biophilic Classroom (Determan et al.)

Research Agenda Conclusions

Based on the completed analysis of research findings, it can be concluded that the traditional classroom fails to support students and teachers alike. With concerns over its rigidity and lack of accommodation for learners, we can reimagine and contribute to the optimization of classroom environments through the lens of flexibility and biophilia. Research, surveys, interviews, and case studies indicate the fundamental need for change. This is supported by teachers' experiences and research that flexibility within the classroom has significantly increased student engagement, promoted collaborative, active learning, and led to academic achievement. All elements will be factored into the Creative Agenda through furniture, equipment, and finish selections. The Literature Review and findings from qualitative research guide design decisions in the Capstone Creative Agenda which aims to optimize classroom learning environments in support of increased student success and teacher effectiveness.

Creative Agenda

Introduction

This capstone project's design proposal aims to promote student engagement, collaboration, and overall success, and increase happiness and effectiveness of instructors through flexible and biophilic design approaches. Utilizing the keys to designing optimized learning environments, four prototypical classrooms are reimagined to focus on adaptability, increased achievement, and well-being. Knowledge gained from the Literature Review including research into the evolution of the classroom, the impact of the physical environment on learning, as well as the key components to optimal learning spaces, provides the information needed to make spaces that foster well-being, productivity, and overall achievement. The Research Agenda also lends additional information directly regarding which design elements teachers correlated with "optimal" environments supportive of both teacher and student success.

Concept Development

The traditional classroom has negatively impacted both the students and teachers within its walls. Moving past the "one-size-fits-all" approach, we can begin to redefine classroom design through the lens of flexibility and biophilia. This focus on well-being and adaptability aims to create engaging, comfortable, and welcoming spaces that enhance learning and overall achievement. Supported by the keys to optimal learning environments, these biophilic and flexible design applications can bring about unforeseen opportunities and success within, and beyond classroom walls.

Together, biophilia and flexibility can positively impact student and teacher success within learning environments. Accomplished

through the implementation of adjustable, moveable furniture, lighting controls, materiality, natural light, and views to nature, the spaces will bring a new balance that doesn't just support academia, but also well-being.



Figure 24: Conceptual Mood Board



Optimized Learning Environment



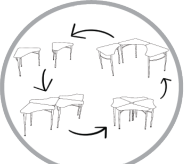
Flexibility



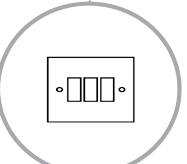
Biophilia



Adjustable Furniture



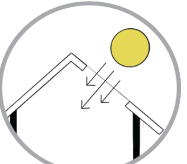
Layouts



Lighting Controls



Views to Nature



Natural Light



Material Application

Figure 25: Conceptual Diagram

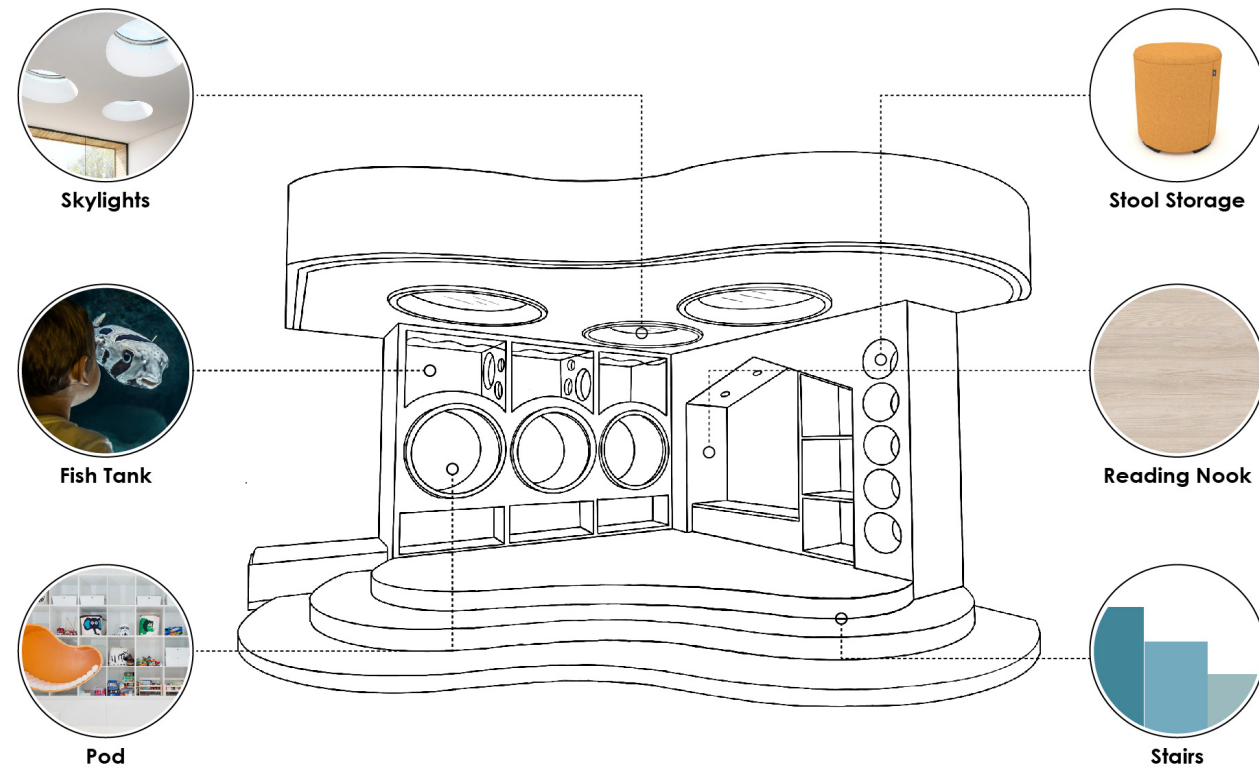


Figure 26: Kindergarten - 2nd Grade Diagram

Design Proposal: Prototypical Classrooms Kindergarten - 2nd Grade

The first classroom, Kindergarten - 2nd grade, holds 30 - 35 students. Given that this classroom requires a variety of play-based activities, it is allotted the largest footprint of the four at 1,350 square feet. In addition to the play-based nature of the space, this classroom aims to 1) Create dynamic zones supportive of communication and developmental skills, 2) Incorporate sensory and tactile elements supportive of student curiosity, 3) Create an engaging, welcoming atmosphere through material application and areas of refuge,

and 4) Utilize natural color tones to compliment young students' active, playful, and energized nature, whilst supporting well-being. Additional considerations include teacher-student sightlines to maintain student safety and behavioral issues, as well as ample storage space as these classrooms typically have various teaching and learning materials. From these points, there was a focus on a central aspect of the design, the reading nook, which looked to introduce areas of refuge with the pods, and elements of biophilia, with the incorporation of skylights, built-in fish tanks, and materiality. Additional areas act as storage for furniture, books, and other items

Throughout this process, four different configurations, 1) Clusters, 2) Pairs, 3) Rows/grid, and 4) Horseshoe, were explored to exhibit the flexibility of the classroom. Accomplished through the use of mobile, collaborative desks and tables, the highly adaptable space can take on a variety of configurations and layouts that support teacher and student experiences and activities within the classroom environment.

In addition to the adaptable nature of this classroom, there are key elements considered which include color, lighting, acoustics, furniture, and biophilia. The palette consists of vibrant and pastel tones of blues and greens which create visual stimulation around the room. Complimented with a variety of natural wood tones, the space is inviting and engaging for these young learners. In addition, sound was approached in a way that is both acoustically and aesthetically effective. With the implementation of preserved mosses within the ceiling, students and teachers can experience direct connections to nature whilst reaping the benefits of an acoustically controlled interior that prevents behavioral issues and attention problems. Lighting applications were also thoughtfully approached, using dimmable LED strips and recessed lighting to aid the natural light that reaches the room. Correspondingly, the windows are outfitted with adjustable shades to control natural light and glare. However, it is suggested that these remain open as natural light and the adjacent garden aid in the well-being of students and teachers within the classroom. Furthermore, the space includes collaborative single desks, uniquely shaped tables, flexible cantilever chairs, wobble stools, a reading nook and dramatic play/sensory pieces that support student needs. In all, these elements collaboratively aid in creating inclusive spaces conducive to the development of student skills and their introduction to school environments.

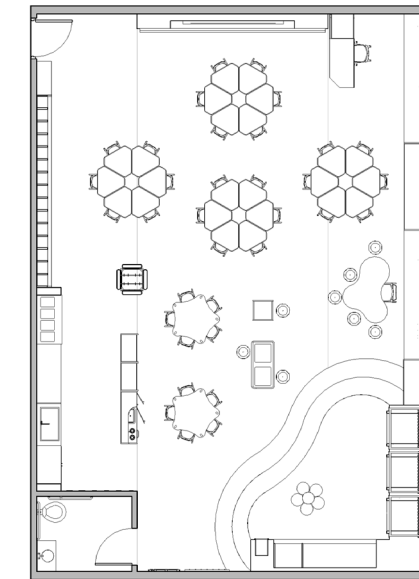


Figure 27: Layout 01 - Clusters

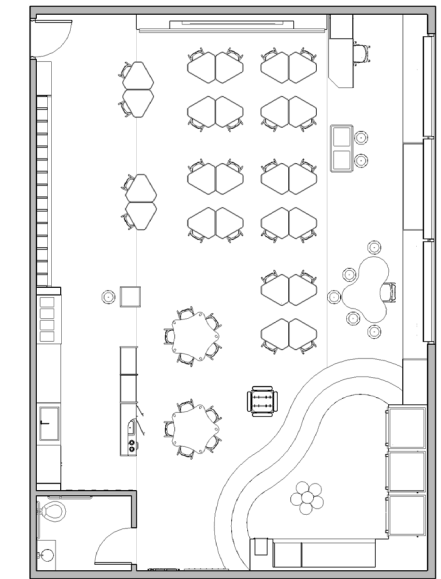


Figure 28: Layout 02 - Pairs

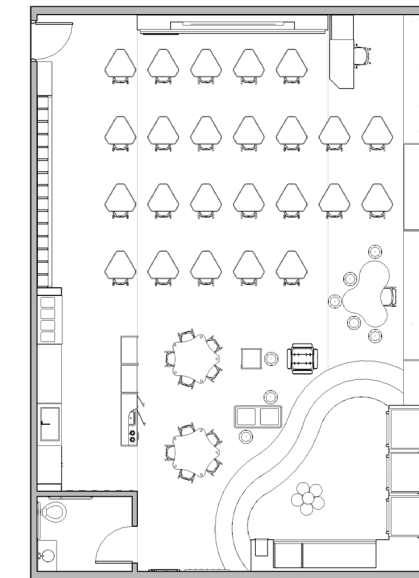


Figure 29: Layout 03 - Rows/Grid

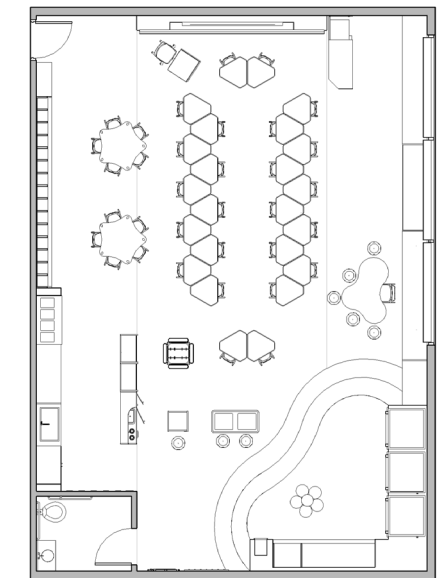


Figure 30: Layout 04 - Horseshoe



Layout 01: Clusters



Layout 01: Clusters



Layout 02: Pairs



Layout 02: Pairs



Layout 01: Clusters



Layout 02: Pairs



Layout 03: Rows/Grid



Layout 04: Horseshoe

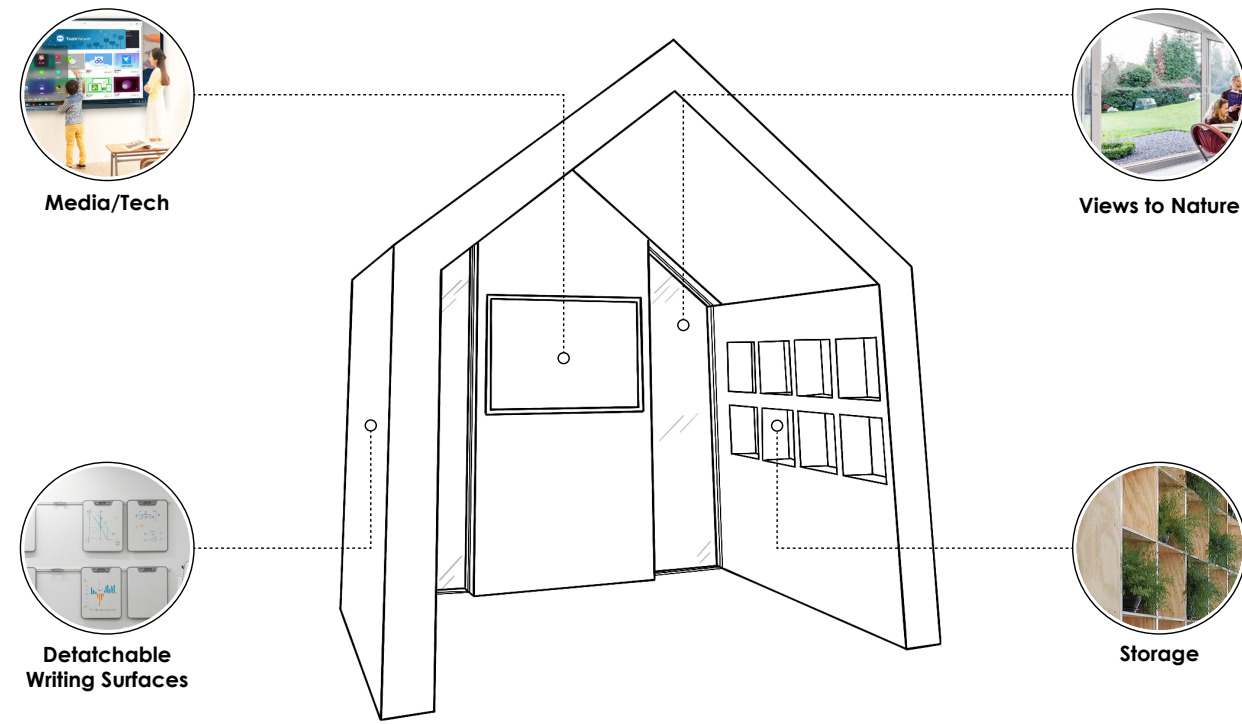


Figure 31: 3rd Grade - 5th Grade Diagram 01

3rd Grade - 5th Grade

The second classroom, 3rd grade - 5th grade, holds 20 - 30 students with a total of 850 square feet. In addition to the primary goal of supporting the transition from play-based activities to more academia, this classroom aims to 1) Create differentiated learning experiences and student choice through the use of collaborative desks and tables, as well as various seating options, 2) Utilize vibrant color tones to support energized nature and create focal points in the room, 3) Enhance biophilic experience with views to nature and places of refuge, 4) Support in-class activities through material application via desks, tables, and additional surfaces that are able

to be written on and 5) Introduce technology through media zones. Again, diagrams were utilized to develop initial ideas of biophilic and media applications, as well as a reading space that would be inclusive and quiet for students. The first diagram aims to introduce media spaces, while also connecting students to nature with the use of floor-to-ceiling windows and "cubby" spaces that can hold potted plants and other classroom materials. In addition, the space is equipped with detachable writing surfaces that can be used anywhere within, and outside of the classroom. The second diagram breaks down the built-in reading nook. With the limitation of storage space in typical classrooms, this offers a solution that

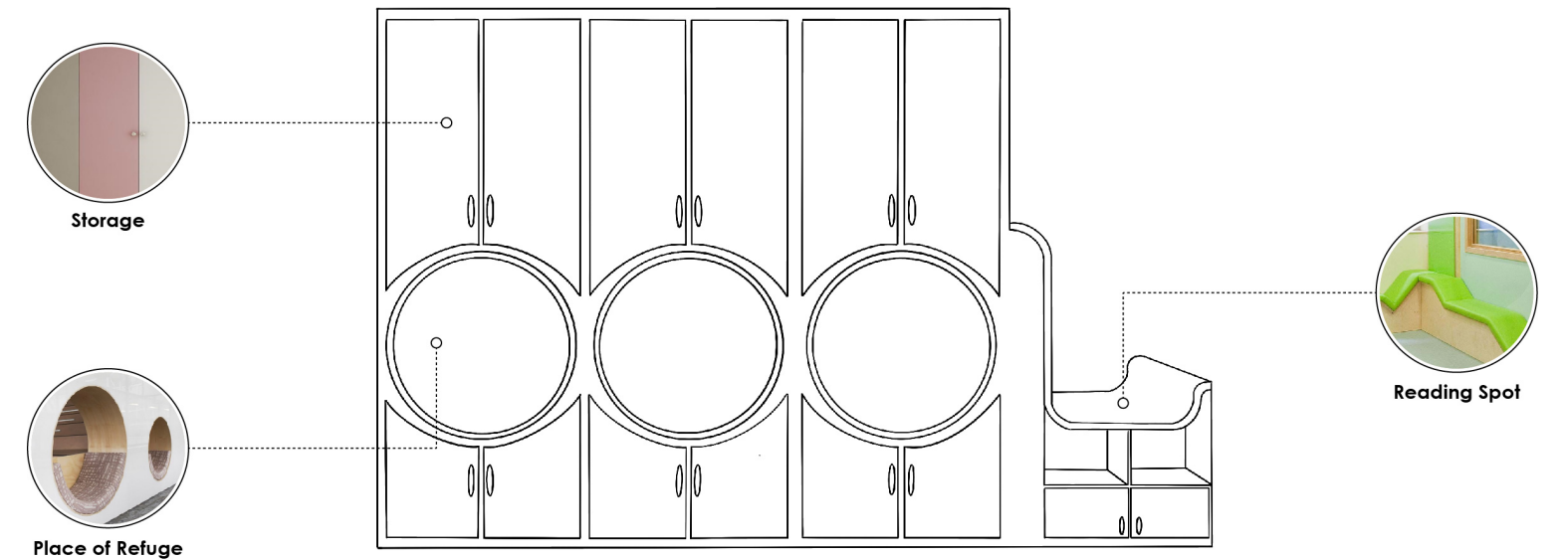


Figure 32: 3rd Grade - 5th Grade Diagram 02

also gives students a place of refuge for reading, de-escalation, and socio-emotional needs.

Again, four configurations, 1) Clusters, 2) Pairs, 3) Rows/grid, and 4) Horseshoe, were explored to display the flexibility of the classroom. Enabled by mobile, collaborative, and adjustable furniture pieces, this classroom is fit to accommodate a variety of instructional activities and layouts.

Key considerations in the design of this space included color, lighting, acoustics, technology, and furniture. The palette pairs vibrant oranges with natural wood tones to compliment these young students' playful, active nature, while also drawing their focus to key learning spaces located at the front and back of the room. In addressing acoustics, there is a felt baffle system which

runs with the focus from the front to the back of the classroom, as well as acoustical ceiling tiles that aid in dampening reverberation and echo within the classroom. Further, lighting applications include dimmable recessed LED strip and canned fixtures. Paired with the adjustable shades on the windows, the lighting aids in producing a comfortable atmosphere. Furthermore, the furniture selections offer a variety of seating choices for the greatest comfort and focus. The collaborative, uniquely shaped single desks and height-adjustable standing desks are for student interaction and engagement. Additionally, the teacher's desk has a mobile element that enables them to move and teach around the room as they need, while two reading spaces are included within the classroom's main built-in casework. In all, these elements aid in the student's transition towards more academia and prepare them for future flexible settings.

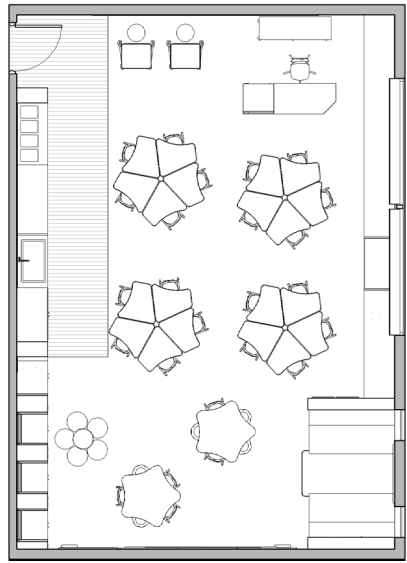


Figure 33: Layout 01 - Clusters

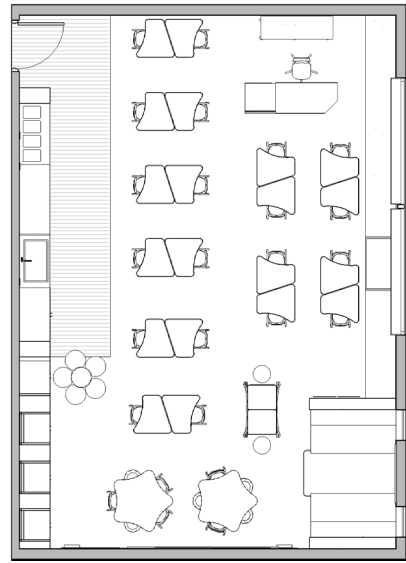


Figure 34: Layout 02 - Pairs



Layout 01: Clusters



Layout 02: Pairs



Layout 03: Rows/Grid

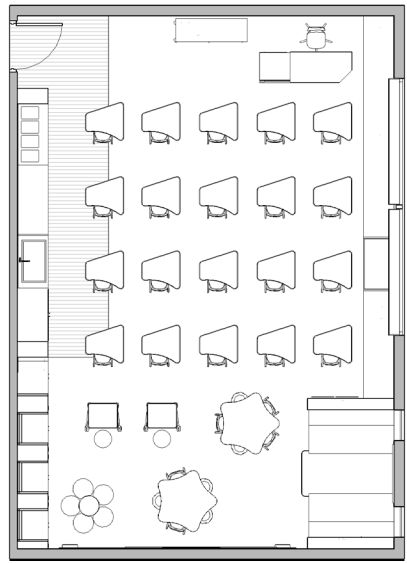


Figure 35: Layout 03 - Rows/Grid

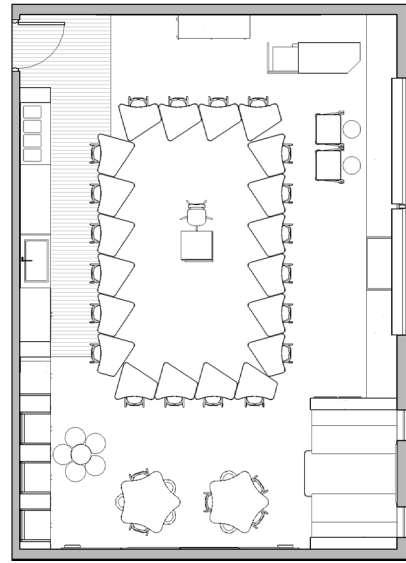


Figure 36: Layout 04 - Horseshoe



Layout 01: Clusters



Layout 04: Horseshoe



Layout 04: Horseshoe

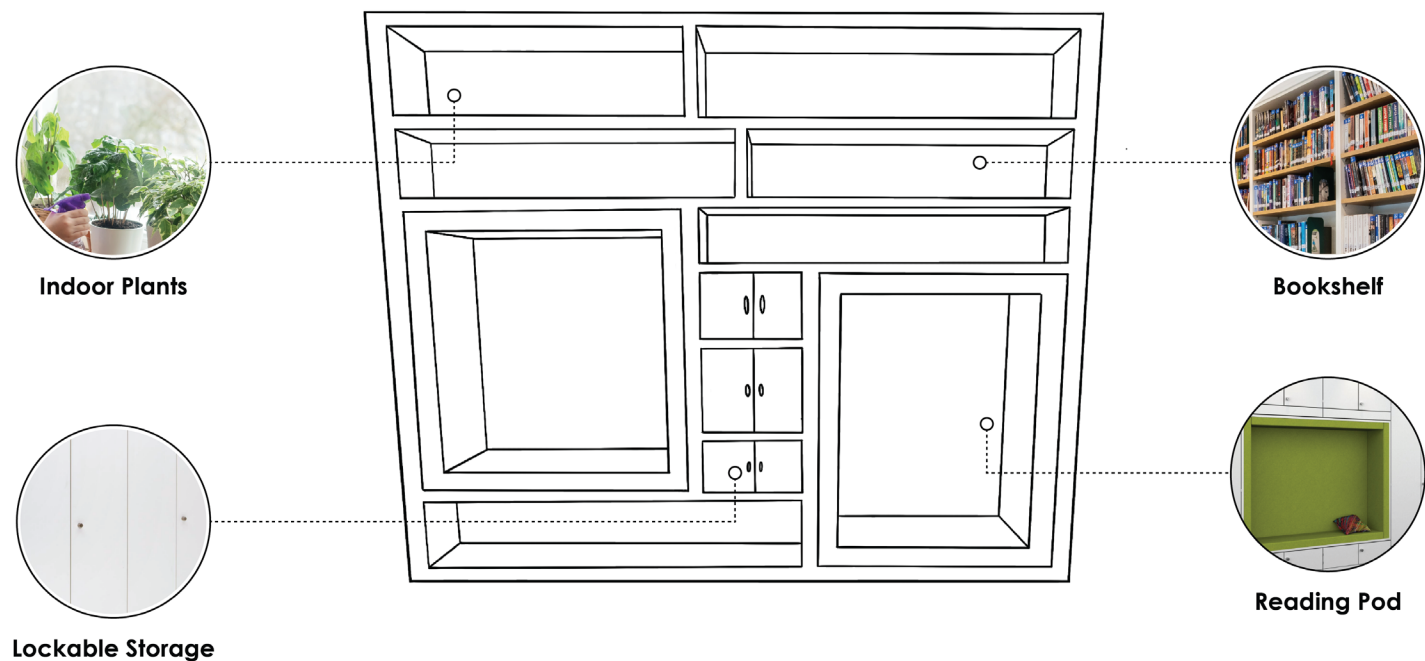


Figure 37: 6th Grade - 8th Grade Diagram

6th Grade - 8th Grade

The third classroom, 6th grade - 8th grade, holds 20 - 25 students with a total of 950 square feet. This pivotal grade change aims to provide a classroom environment that supports and prepares students for a more sophisticated high school learning experience. That said, the main goals of the space include 1) The implementation of more sophisticated media areas that support the flexibility of the room, 2) The incorporation of various furniture options that support class mobility and support various student working preferences, and 3) The use of a sophisticated material palette that promotes concentration, relieves feelings of anxiety, and enhances the

biophilic experience. A primary element introduced within this classroom is a dedicated lounge area which is accompanied by the built-in reading nook. The diagram above demonstrates how this space confines two reading pods, spaces for lockable and open storage, as well as opportunities to introduce plants to the interior environment. For students, this is meant to be a place of refuge that offers moments of de-escalation, as well as a breakaway working/learning area as it interacts with the adjacent lounge space.

Four different configurations, 1) Clusters, 2) Pairs, 3) Rows/grid, and

4) Horseshoe, were explored to convey the flexibility of the classroom. That said, the flexible furniture options enable teachers to use a variety of configurations based on varying instructional activities.

The palette of this classroom consists of several green, blue, and light wood tones reminiscent of nature. Following the trend of the other rooms, color is used to draw focus from the front to the back of the classroom while also defining different learning spaces. All the furniture within the room is movable, and for the most part, adjustable or modular. The triangular-shaped desks accommodate both collaborative and individual learning, while other pieces, including the height-adjustable standing desks and stools, media center, mobile benching/storage units, and modular lounge pieces aid in the long-term adaptability of the space and the accommodation of an extensive range of individuals. Furthermore, perforated linear veneer planks are utilized as both a biophilic and acoustical tool with their natural wood look and sound-reducing qualities. Additionally, LED lighting is used in the form of recessed can and linear strip lighting, accompanied by adjustable shades on the windows. Some other features within this classroom include the hexagonal acoustical wall tiles which can double as a tack board for hanging up student work, as well as the abundance of writing surfaces both on the walls and desktops. Overall, with a key goal of providing a variety of flexible and adjustable working/learning options around the room, students are allowed to relax, focus, and engage on their own terms. This allows for an optimal environment that supports the success of students and the effectiveness of teachers.

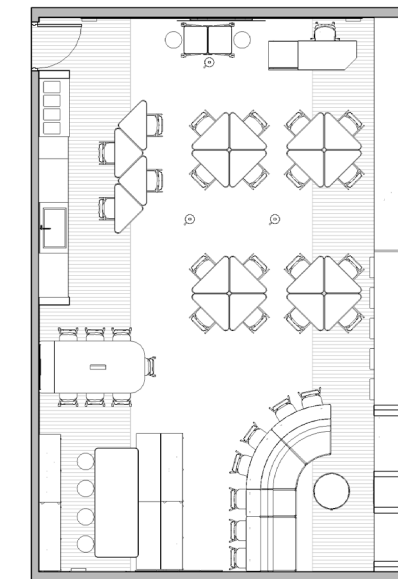


Figure 38: Layout 01 - Clusters

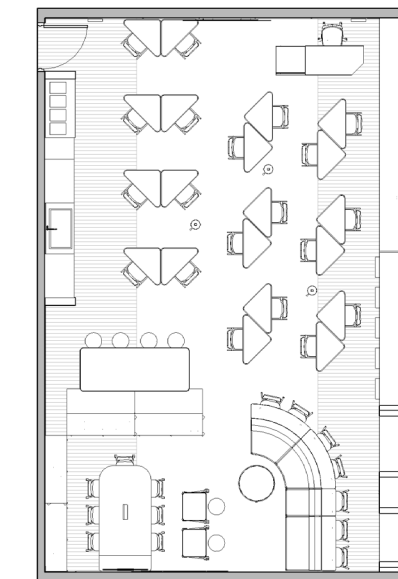


Figure 39: Layout 02 - Pairs

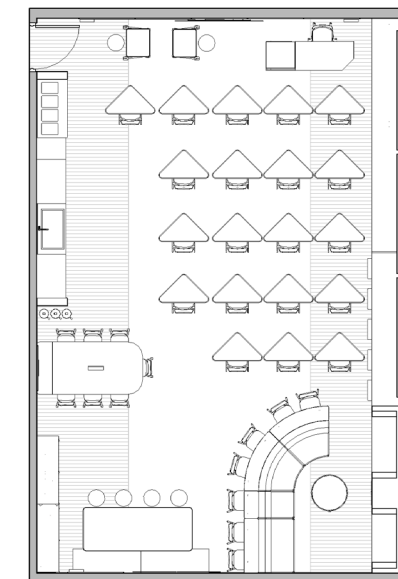


Figure 40: Layout 03 - Rows/Grid

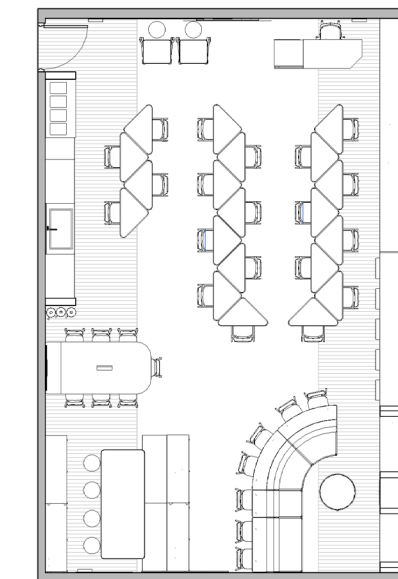


Figure 41: Layout 04 - Horseshoe



Layout 01: Clusters



Layout 01: Clusters



Layout 02: Pairs



Layout 02: Pairs



Layout 01: Clusters



Layout 01: Clusters



Layout 03: Rows/Grid



Layout 04: Horseshoe

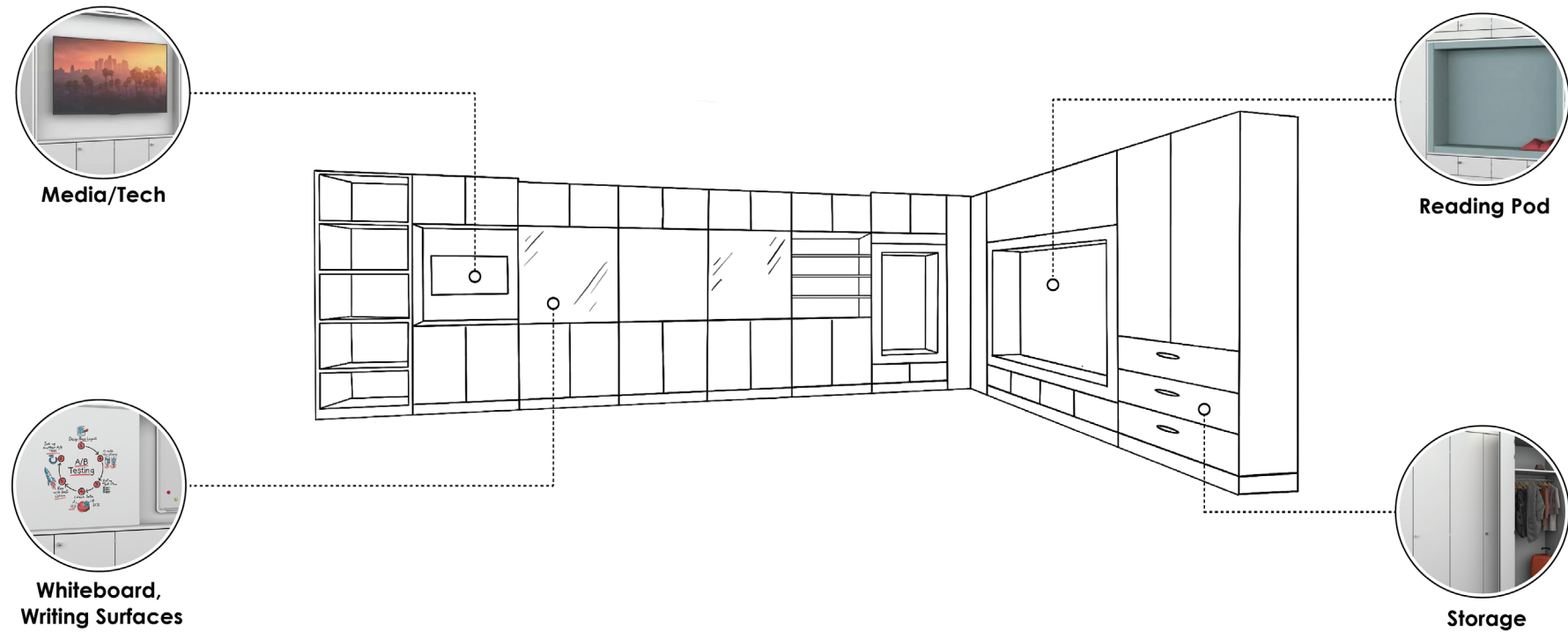


Figure 42: 9th Grade - 12th Grade Diagram

9th Grade- 12th Grade

Lastly, the 9th grade - 12th grade, or high school classroom accommodates 25 - 30 students with a total of 1000 square feet. Being a support to the transition of college and/or other learning and working experiences, this classroom aims to 1) Incorporate the most variety of seating options that support various instructional activities and classes, 2) Provide collaborative single desks that foster collaborative working environments, 3) Support technology with media zones, tech management, and storage, and 4) Utilize a mix of cooler and vibrant colors to promote concentration and determine focal points around the room. The diagram above

demonstrates the back area of the room which provides reading pods, a media/tech zone, storage for classroom materials, and an additional learning space equipped with moveable white and tack board surfaces. Overall, these units are meant to reflect the sophistication of learning spaces as students make their way toward higher education and achievement.

Four different configurations, 1) Clusters, 2) Pairs, 3) Rows/grid, and 4) Horseshoe, are displayed to communicate the flexible nature of the classroom. Outfitted with more traditional, rectangular desks, the room remains adaptable with moveable, adjustable, and

modular pieces that make for a conducive learning and teaching environment.

The high school room consists of a more sophisticated palette with a combination of dark and light blue tones and medium woods. In addition, there is the use of natural wall graphics to incorporate an aspect of biophilia. Using methods similar to the other classrooms, there is a central area that guides users' attention toward the front and back areas of the space. Here, there are several felt acoustical ceiling baffles that help to dampen sound and dimmable LED lighting. Additionally, this classroom features the most variety within seating spaces and work surfaces. There are three stool options, supporting movement side to side, height-adjustability, or comfort. This variety allows for student choice and is even found to significantly improve students' learning, anxiety, memory retention, and exam outcomes. The single desks and tables are more traditional shapes; however, they remain easily reconfigurable and moveable for different activities whether it be group or individual working/learning settings. Technology is also incorporated within the front and back zones of the classroom. In today's age, adaptability within classrooms can include the ability to hold online classes. Supporting both at-home and in-class students, this space is made to accommodate hybrid learning without any struggles. In all, this environment encourages students to engage, collaborate, and learn in the way that they want. Offering flexibility in the classroom through adjustable, mobile, and collaborative furniture is key to student engagement and overall success in high school classroom environments.

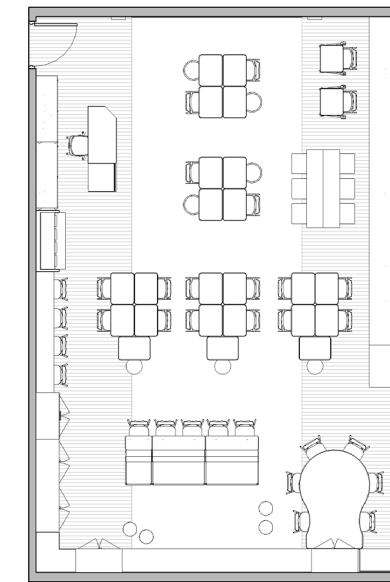


Figure 43: Layout 01 - Clusters

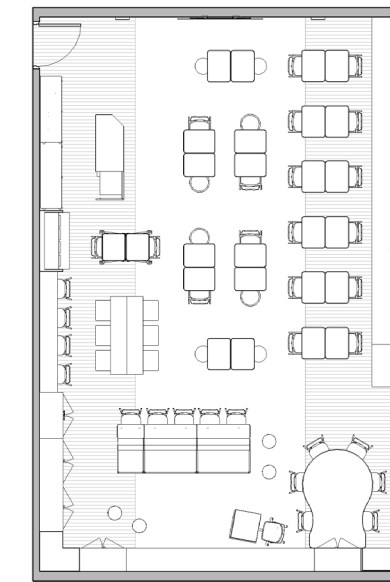


Figure 44: Layout 02 - Pairs

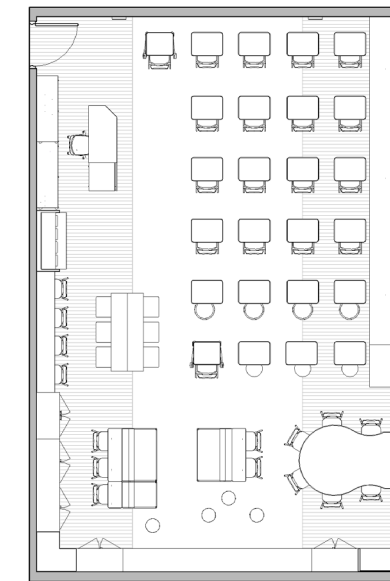


Figure 45: Layout 03 - Row/Grid

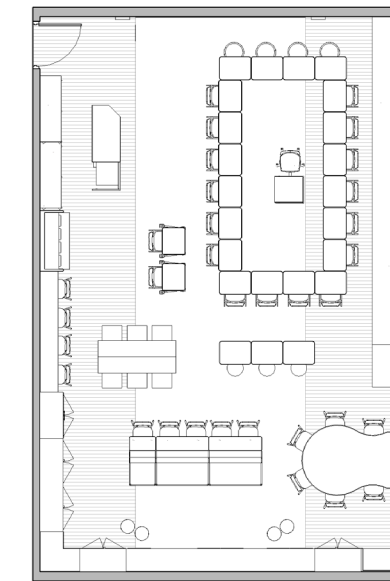


Figure 46: Layout 04 - Horseshoe



Layout 01: Clusters



Layout 01: Clusters



Layout 02: Pairs



Layout 03: Rows/Grid



Layout 01: Clusters



Layout 02: Pairs



Layout 04: Horseshoe



Layout 04: Horseshoe

Capstone Summary and Conclusion

Project Extensions: Learning Corridors

Hallways already take up large amounts of usable space within a building, and with schools looking to maximize efficiency and exploration, they have been looked to in creating learning spaces outside of the classroom. Utilizing corridors as learning spaces doesn't replace learning in the classroom, but instead increases the flexibility of underutilized spaces within schools and gives a visually different atmosphere for students and teachers. So far, they have been shown to improve the quality of school by locating learning both within and outside of classrooms, expose students to differentiated learning environments, and ultimately get the most square footage out of projects. Accomplished through foldable, mobile tables, media displays and walls, as well as writing surfaces, learning corridors are pushing the boundaries of learning.

Creative Agenda Conclusions

The goal of this undergraduate capstone project's Creative Agenda was to provide a design approach for optimized learning environments in K-12 education through the lens of flexibility and biophilia. This concept shifts K-12 design approaches toward achieving increased student success and teacher effectiveness through modern, comfortable spaces that foster well-being and promote adaptability. There is no "one-size-fits-all" answer, however, there are methods and steps toward creating a learning environment conducive to a broad range of learners. In all, the evidence to support the design proposal is grounded in the physical environment's ability to impact student achievement, and how effective color, lighting, acoustics, technology, space planning, furniture, and biophilic applications can create engaging, collaborative environments that positively impact student and teacher success within learning environments and prepare them for future learning and/or working opportunities.

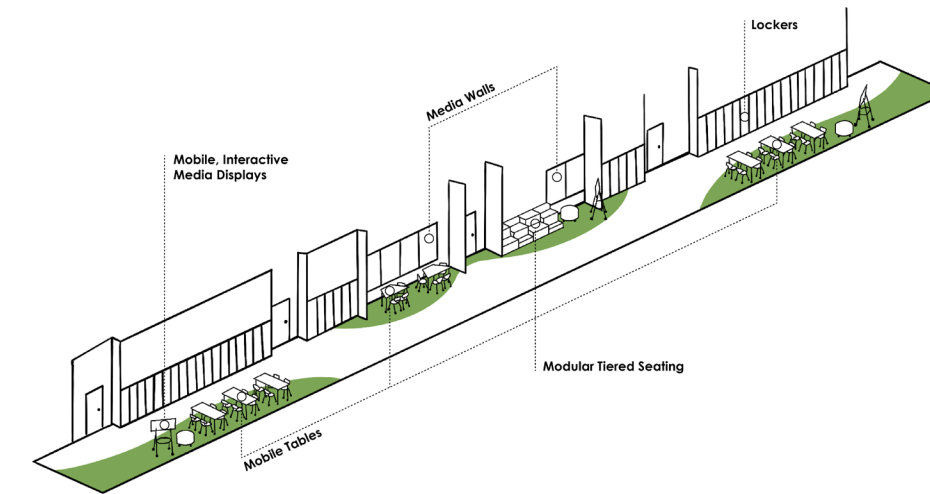
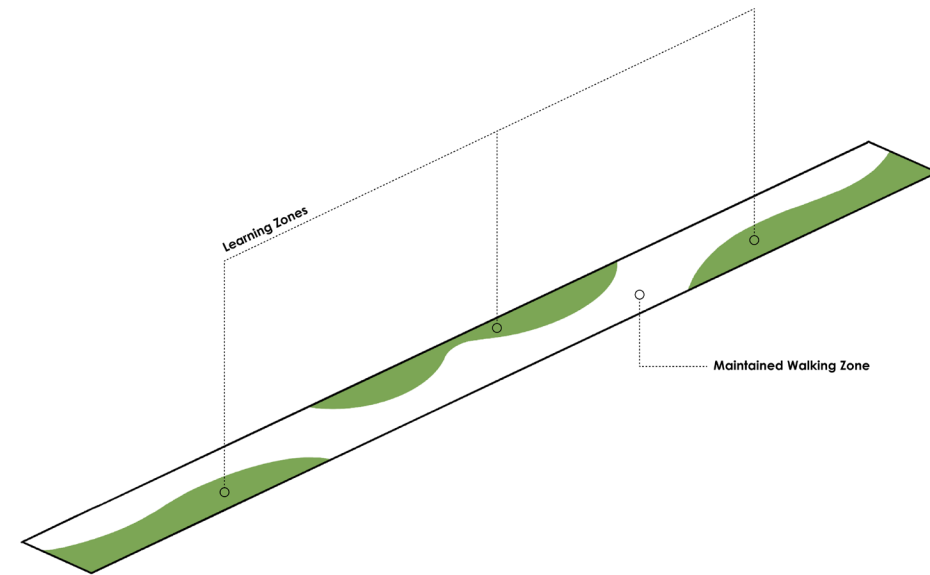


Figure 47: Learning Corridors

With growing concerns over student learning, engagement, and productivity, designers have begun seeking new initiatives for K-12 design. With evidence supporting the substantial impact a classroom has on student and teacher achievement, it is more important than ever to approach educational design in a way that puts student and teacher needs at the forefront.

The main goal of this undergraduate capstone project is to answer the question, how can forward-thinking, flexible, and biophilic design approaches enhance student success and teacher effectiveness in the classroom environment? As shown in the Literature Review and Research Agenda sections of this manuscript, evidence-based design strategies are used to make informed decisions on design elements that positively impact student motivation, engagement, and overall success, as well as the effectiveness of teachers. Abandoning traditional ways, we must seek solutions that prioritize student-centered learning, critical thinking development, and interconnectivity through the tactical uses of color, lighting, acoustics, technology, space planning, furniture, and biophilia. We are aware that children learn in a variety of different ways and rates, therefore, through the lens of flexibility and biophilia, we can create environments conducive to learning for an extensive range of individuals.

To conclude, forward-thinking, flexible, and biophilic design approaches can enhance student achievement and teacher effectiveness within the classroom environment to positively impact the well-being and overall success of users.

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Appendices

Appendix A. Prospectus



Interior Design Capstone Prospectus

Capstone Candidate: Mak Friery

School: College of Art and Design, School of Design
Rochester Institute of Technology

Program: Interior Design

Capstone Title

Escaping Tradition: An Exploration of Optimized Learning Environments

Research Question

How can forward-thinking design approaches improve student success and teacher effectiveness in the classroom environment?

The Capstone Justification

We are aware that children learn in various ways and progress at different rates. Despite this knowledge, most of our schools are still set up for the “sage on the stage” approach which encourages the traditional lecture style of teaching and memorization (Gaspary). This may have made sense in a time when collaboration and critical thinking were not seen as necessary skills for a productive citizen, however, in today’s fast-paced environment these skills are vital in any industry. To “master” the 21st-century skills of today, there is a necessity for a variety of spaces and teaching methods. With the onset of the COVID-19 pandemic, we were able to see the extent to which the traditional educational environment fails us. With the heightened recognition of its failures to students and instructors alike, schools have begun to seek solutions that approach learning in an entirely new way. Throwing away the “one size fits all” narrative, K-12 design approaches have begun prioritizing student-centered learning, critical thinking development, and interconnectivity. These innovative approaches not only allow for multiple modes of teaching and learning but also allow students and teachers to transition seamlessly. This undergraduate interior design capstone explores the keys to creating an optimized learning environment across pivotal grade levels. The hypothesis is that with the close study of forwardthinking, flexible design approaches, we can identify what it takes to enhance both student success and teacher effectiveness in the classroom.

Literature Review

At the turn of the 20th century, schools saw a rapid increase in student enrollment as a result of new education mandates and laws banning child labor. In response, most classroom layouts looked to maximize floor space with rows of fixed desks while the instructor lectured from a raised podium. Though we have come a long way from schoolhouses, we continue to see these teaching and space planning trends in the current day (Brite). This Literature Review aims to investigate approaches to creating optimal learning environments in K-12 classrooms through reconfiguring classroom environments, incorporating key design components, and prioritizing student-centered learning are critical as it pertains to student success and teacher effectiveness. The proposed outcome will enable students to have control over their educational success and provide alternative solutions to learning while also equipping teachers with the tools needed to enhance learning.

The following will be investigated through the Literature Review: history of traditional classrooms, the evolution of classroom design, problems seen within traditional classrooms (ex. lack of accommodation for different learning styles to lack of attention to physiological factors), alternative solutions to combatting the issues of traditional classroom design.

Research Agenda

To investigate and inform a research agenda, qualitative and quantitative data will be collected to defend the design thinking and creative agenda of this thesis proposal. This approach will allow the focus on the key aspects of the classroom experience; lighting, acoustics, temperature, layout, air quality, accessibility, and other necessities that are vital in creating an optimal learning environment. Research methods will include:

- **Case Studies** – Finding projects that focus on student-centered learning and design that enhances teacher effectiveness and student success. These will be analyzed on design elements and the overall approach to creating the most optimal classroom environment.
- **Surveys** – Forming questions and conducting surveys (directed to instructors and students) to obtain first-hand perspectives of effective design approaches. The resulting data will inform concerns students and educators face in current learning environments.
- **Interviews** – Preparing questions to interview designers, manufacturers, and teachers to understand successful approaches with the key design elements in mind. This can allow the chance to obtain qualitative data from first-hand sources that encounter struggles with the classroom environment daily.
- **Analysis** – Analyzing statistical and graphic information relating to key aspects, identifying the needs of students and instructors, identifying factors of well-being, health, and safety, observing materiality, palette, and ergonomic features, and identifying key design components that correlate with student success and teaching effectiveness

Simmons, Kate, et al. “Exploration of Classroom Seating Arrangement and Student Behavior in a Second Grade Classroom.” Georgia Educational Researcher, vol. 12, no. 1, 2015, pp. 52–65., <https://doi.org/10.20429/ger.2015.120103>.

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- FF&E – Identifying key lighting fixtures/temperatures that are proven to increase student success, and locating additional research to identify durable, flexible, and reliable furniture manufacturers that have designs based on the MLE (Modern Learning Environment)/FLE (Flexible Learning Environment)
- Documentation – Looking to gain additional research collection through meetings with committee members to provide a valuable research extension, identifying existing consequences, downfalls, and failures of the traditional classroom model

Overall, the findings from the research agenda will form the defense that breaking away from traditional educational environments in favor of forward-thinking approaches and methods will allow for increased student success and teacher effectiveness.

Creative Agenda

This Creative Agenda proposes to utilize the Literature Review and Research Agenda to make 4 prototypical classrooms. Focused on the pivotal grade levels of kindergarten – 2nd Grade, 3rd Grade – 5th Grade, 6th Grade – 8th Grade, 9th Grade – 12th Grade, I will seek solutions that address the issues of the traditional classroom.

This Creative Agenda proposes to include:

- New approaches to design through modern learning environment application in the educational setting
- Sustainable material application
- Suitable color selections for each age group prototypical classroom
- Biophilic principles as they relate to increased productivity in the classroom
- Appropriate lighting fixtures and temperatures
- Integration of technology that assists learning
- Layouts for various teaching methods (Collaborative, Social, Flipped, and feedbackbased learning)

Summary

The aim of this capstone is to investigate approaches to creating an optimal classroom environment. The research methods, case studies, surveys, and interviews will identify appropriate methods and approaches to substantiate design strategies for the Creative Agenda to implement design elements that enhance learning and teacher effectiveness.

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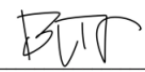
Gaspary, Callie. "Associate Partner Callie Gaspary's Article, Reimagining The Learning Environment, Shares Some Great Tips for Local Educators in the Albany Business Review's Schools Report. Read It below." Mosaic Associates Architects, 2 July 2019, <http://www.mosaicaa.com/reimaginingthe-learning-environment-article-in-albany-business-review/>.

Acknowledgements

Signatures from committee members are added to the prospectus via electronic signature. If one or more signature .pdf is obtained, combine the individual signature documents into one using a .pdf writer.

The Undergraduate Interior Design Capstone proposed by the above-named student has been approved without reservation or with the attached reservation(s).

Capstone Chair: Isabella Trindade Date Oct 2nd, 2022
(e-Signature)

Committee Member:  Date 9/13/22
(e-Signature)

Committee Member:  Date 10-11-2022

Appendix B. Survey Platform

Link: https://rit.az1.qualtrics.com/jfe/form/SV_3eg4YHXlueYnuTA

Appendix C. One to One Interview Questions

Interview Questions

Q1: What grade level(s) do you teach or have you had experience teaching?

Q2: What subject do you teach?

Q3: What are the major issues that you face within your current classroom or classrooms you've taught in before?

Q4: What changes to the design of your classroom do you believe would optimize the experience?

Q5: Do you struggle to engage students in teaching materials?
a. Have you found that certain teaching approaches or methods keep students more engaged than others?
b. Do you think height-adjustable and movable furniture would help engage students better?

Q6: Do you rearrange your classroom in different layouts often?
a. If not, do you think it would be a good option for keeping students engaged and/or beneficial for specific instructional activities?
b. Do you think movable desks and chairs would make rearranging easier and/or faster?
c. Do you think casters on furniture would increase distractions?

d. Is there anything else you think would be helpful for rearranging the classroom?

Q7: What is the furniture like that you have in your current room?
a. Have you found that this furniture impacts students' learning (is it distracting or uncomfortable)?
b. Do you think various seating types would help? (stools, soft seating, exercise ball, sit-to-stand, height-adjustable)
c. Do you think having soft seating as an option would be distracting or helpful for students? (distracting or comfort brings focus)

Q8: Have you found that lighting impacts student engagement?
a. What seems to be the most effective lighting? (dimming controls, warm temperature, cooler temperature, some lights on and off, natural light)
b. Do you think adjustable shading capabilities for windows would be beneficial to have in a classroom?

Q9: Do you think elements of biophilia like natural light, indoor plants, and natural colors would enhance students' and even your own experience in the classroom?
a. What do you see as viable options for application? (like floor-to-ceiling windows, indoor plants, a plant wall, natural patterns in furniture and finishes)
b. Now knowing the benefits of biophilia for both students and teachers, would you support its application in the educational environment?

Q10: Do you think color impacts student learning?
a. Have you found certain colors to either hinder or increase

student engagement?
 b. Would you prefer bright or neutral colors in the classroom?

Q11: Is noise an issue within your classroom?
 a. Do you also find that this noise interrupts classroom instruction and student focus?
 b. Have you found anything that prevents this?

Q12: How often is technology embedded within instruction and classroom activities?
 a. Do you find that this helps with student engagement?
 b. Do you think there should be dedicated tech spaces within the classroom?
 c. Do you think mobile interactive whiteboards would help with teaching and student participation?

Q13: Lastly, are there any additional suggestions you have for designing an optimal classroom environment?

Additional Questions for Interviewees 02 and 03

Q1: You have recently been given newer, modern furniture options. Could you tell me how it has helped with your teaching and/or student engagement?

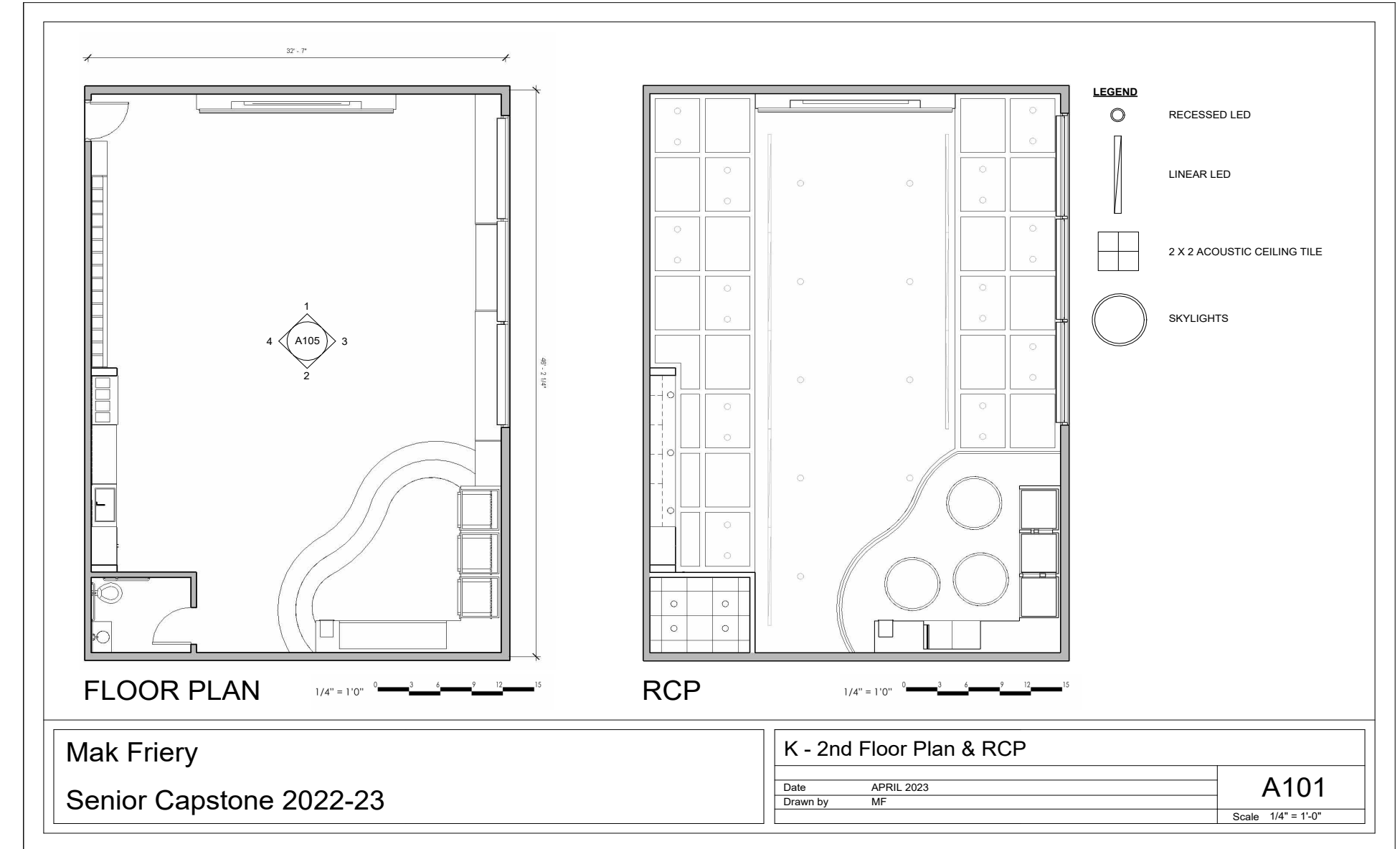
Q2: What furniture options have you found the most beneficial for student engagement?

Q3: Does this new furniture enable you to rearrange the room according to specific activities?

Q4: What tools/items do think would increase your effectiveness?

(new tech, movable interactive displays, movable centers/ furniture, mobile desk, steam spaces)

Appendix D. Architectural Drawing Set



① K - 2ND GRADE FRONT ELEVATION
3/16" = 1'-0"

② K - 2ND GRADE BACK ELEVATION
3/16" = 1'-0"

③ K - 2ND GRADE SIDE ELEVATION 01
3/16" = 1'-0"

④ K - 2ND GRADE SIDE ELEVATION 02
3/16" = 1'-0"

Mak Friery		Kindergarten - 2nd Elevations	
Senior Capstone 2022-23		Date	APRIL 2023
		Drawn by	MF
		A102	
		Scale 3/16" = 1'-0"	

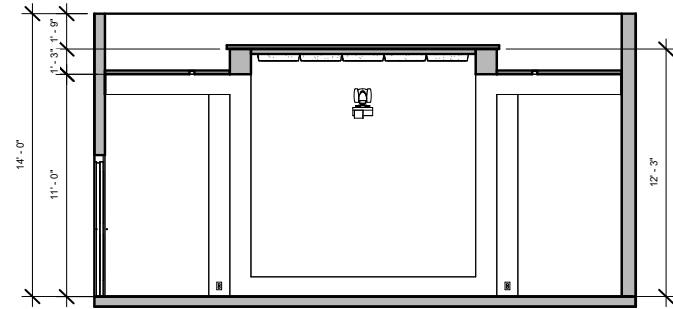
FLOOR PLAN 1/4" = 1'-0"

RCP 1/4" = 1'-0"

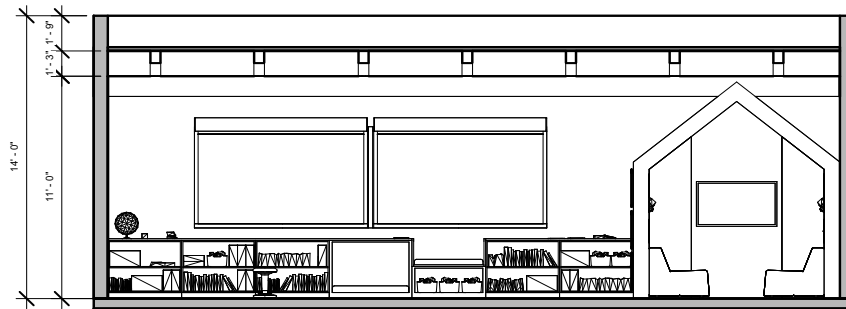
LEGEND

- RECESSED LED
- ▭ LINEAR LED
- 2 X 4 ACOUSTIC CEILING TILE
- ◻ TURF PORT ACOUSTIC CEILING TILE

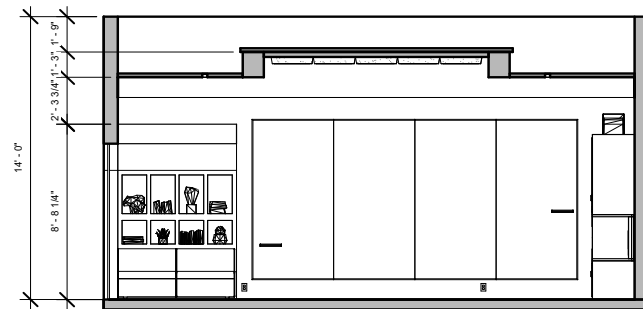
Mak Friery		3rd - 5th Floor Plan & RCP	
Senior Capstone 2022-23		Date	APRIL 2023
		Drawn by	MF
		A103	
		Scale 1/4" = 1'-0"	



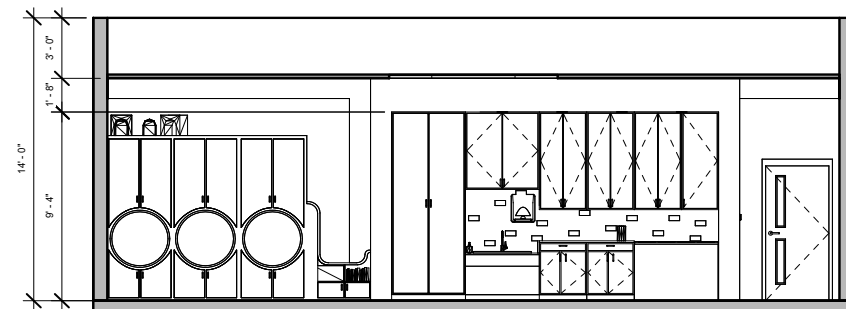
① 3RD - 5TH GRADE FRONT ELEVATION
3/16" = 1'-0"



③ 3RD - 5TH GRADE SIDE ELEVATION 01
3/16" = 1'-0"



② 3RD - 5TH GRADE BACK ELEVATION
3/16" = 1'-0"

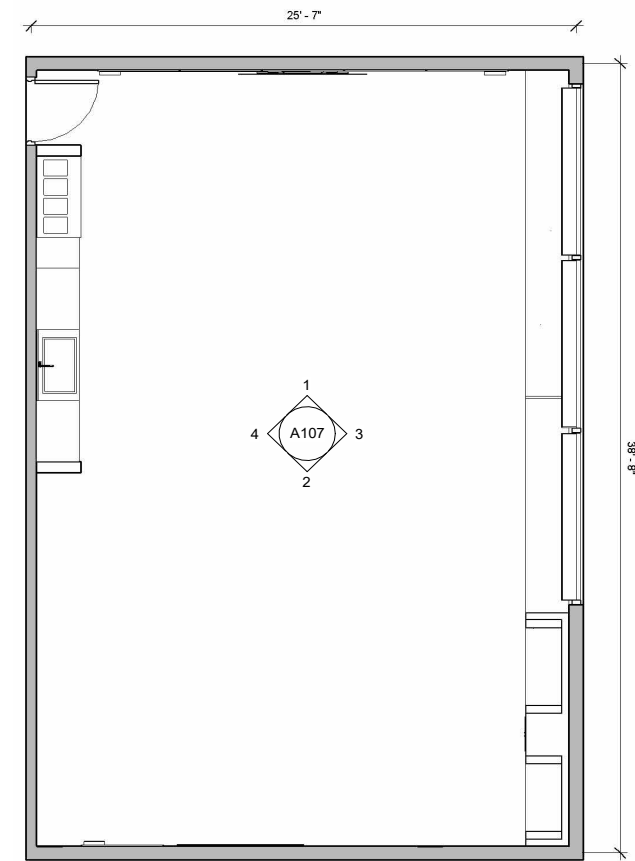


④ 3RD - 5TH GRADE SIDE ELEVATION 02
3/16" = 1'-0"

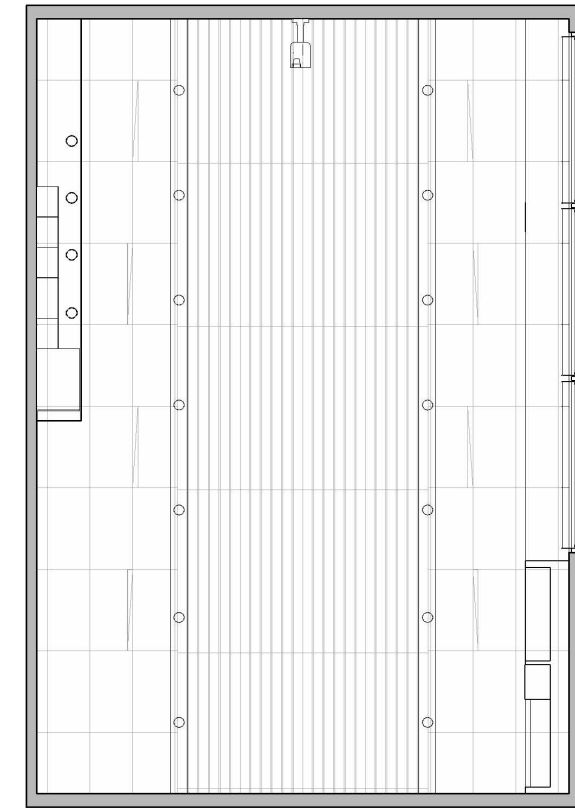
Mak Friery
Senior Capstone 2022-23

3rd - 5th Elevations

Date	APRIL 2023	A104
Drawn by	MF	
Scale		3/16" = 1'-0"



FLOOR PLAN 1/4" = 1'-0"



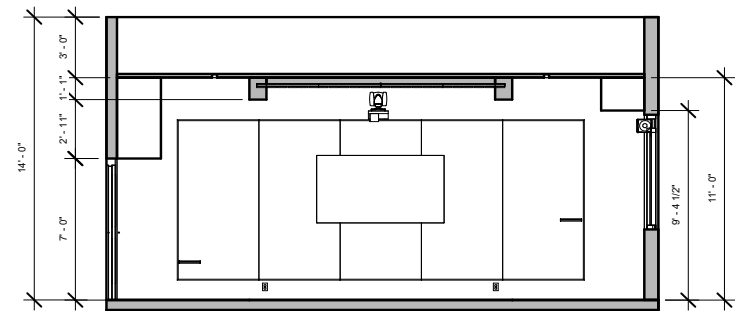
RCP 1/4" = 1'-0"

- LEGEND**
- RECESSED LED
 - LINEAR LED
 - 2 X 4 ACOUSTIC CEILING TILE
 - ARMSTRONG CEILING PANEL

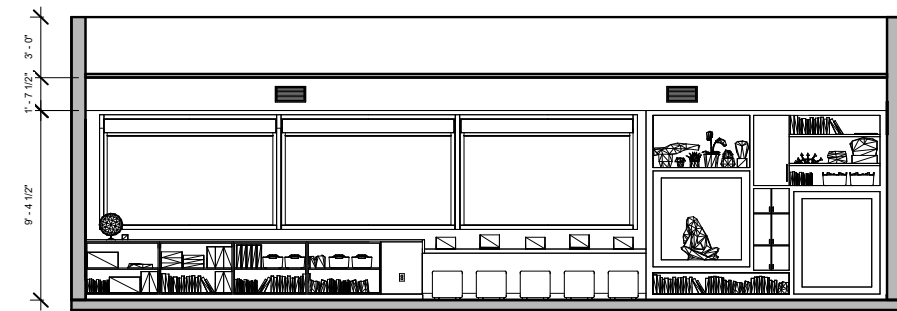
Mak Friery
Senior Capstone 2022-23

6th - 8th Plan & RCP

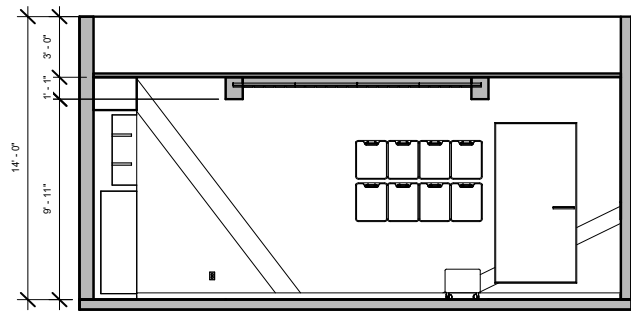
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Drawn by	MF	
Scale		1/4" = 1'-0"



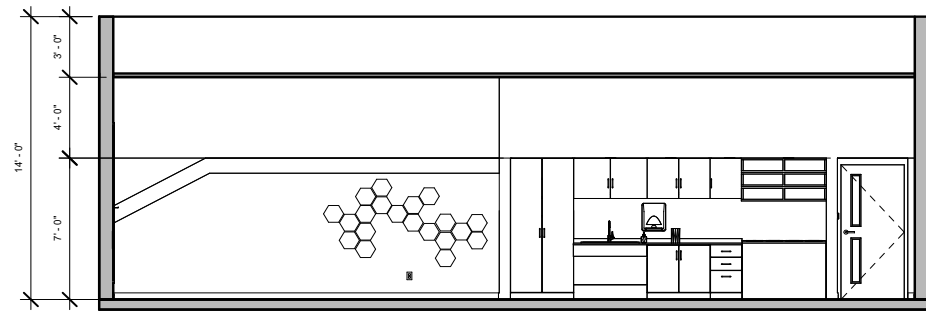
① 6TH - 8TH GRADE FRONT ELEVATION
3/16" = 1'-0"



③ 6TH - 8TH GRADE SIDE ELEVATION 01
3/16" = 1'-0"



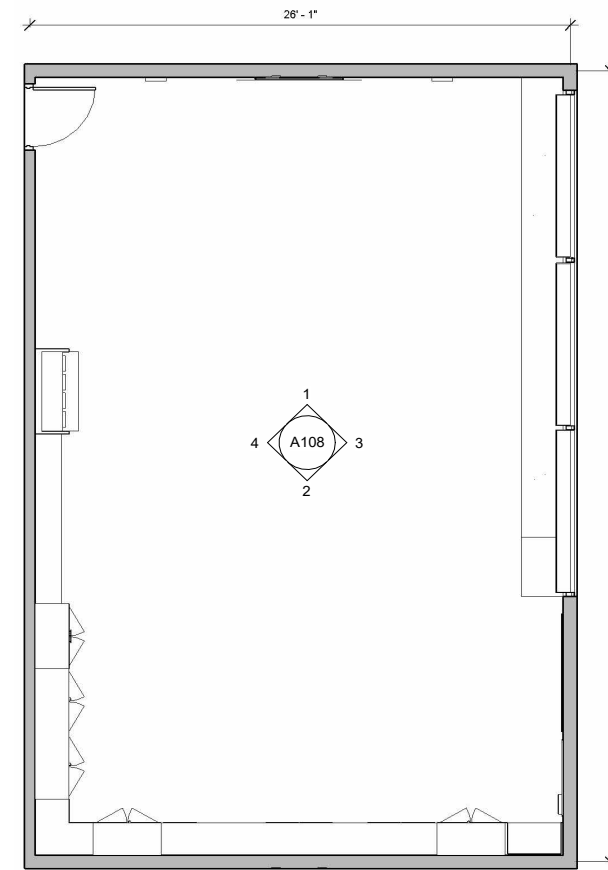
② 6TH - 8TH GRADE BACK ELEVATION
3/16" = 1'-0"



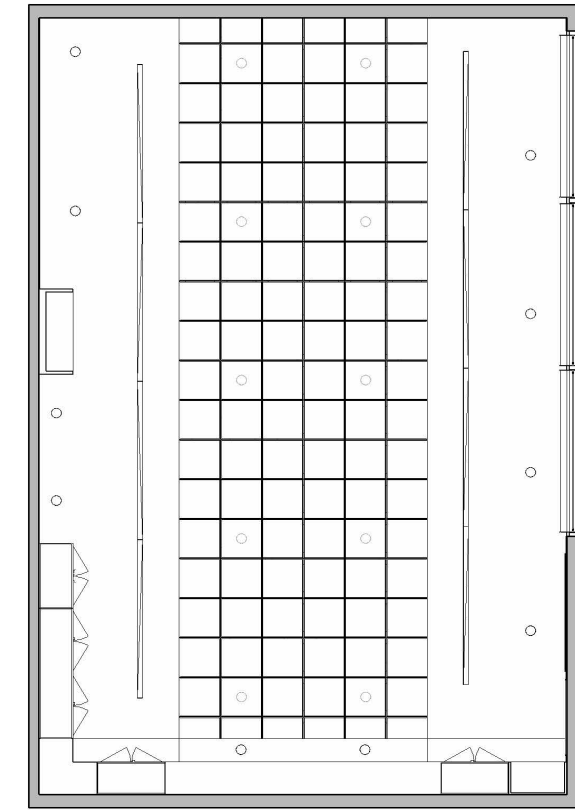
④ 6TH - 8TH GRADE SIDE ELEVATION 02
3/16" = 1'-0"

Mak Friery
Senior Capstone 2022-23

6th - 8th Elevations		A106
Date	APRIL 2023	
Drawn by	MF	Scale 3/16" = 1'-0"



FLOOR PLAN 1/4" = 1'-0"

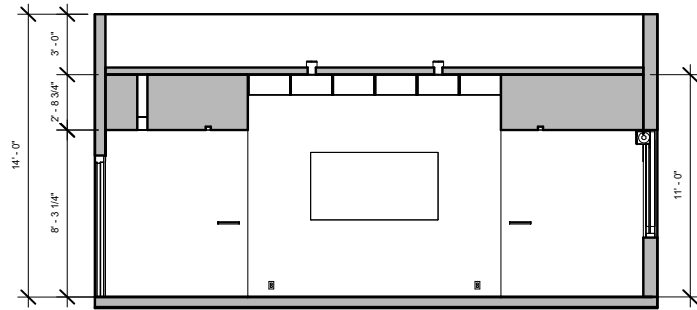


RCP 1/4" = 1'-0"

- LEGEND**
- RECESSED LED
 - LINEAR LED
 - 2 X 2 ACOUSTIC CEILING TILE
 - TURF SWITCHBLADE ACOUSTIC CEILING BAFFLE

Mak Friery
Senior Capstone 2022-23

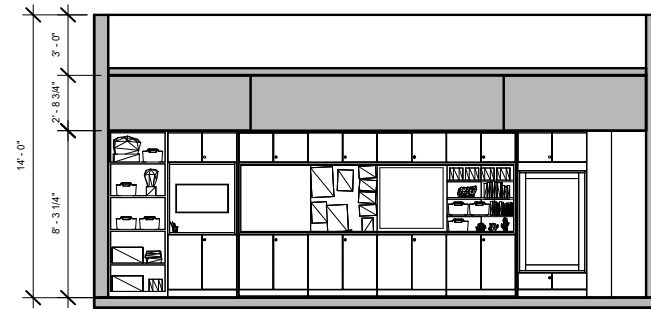
9th - 12th Floor Plan & RCP		A107
Date	APRIL 2023	
Drawn by	MF	Scale 1/4" = 1'-0"



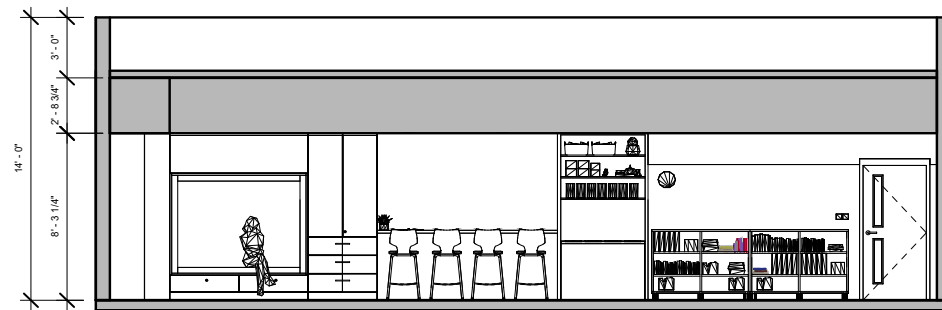
① 9TH - 12TH GRADE FRONT ELEVATION
3/16" = 1'-0"



③ 9TH - 12TH GRADE SIDE ELEVATION 01
3/16" = 1'-0"



② 9TH - 12TH GRADE BACK ELEVATION
3/16" = 1'-0"



④ 9TH - 12TH GRADE SIDE ELEVATION 02
3/16" = 1'-0"

Mak Friery
Senior Capstone 2022-23

9th - 12th Elevations

Date	APRIL 2023	A108
Drawn by	MF	
		Scale 3/16" = 1'-0"

