The Physical Classroom Environment: A Key to Inclusion and Student Engagement

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We accept this Applied Project as conforming to the required standard.

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Abstract

The physical environment of the classroom has a significant impact on students. This impact is even more significant for students with learning difficulties. Understanding how the classroom environment impacts inclusion and engagement is an important aspect of creating schools that meet the needs of all students. Educators can benefit from having more insight and examples of evidence-based practices that help to create more engaging and inclusive classroom environments. This project focuses on various aspects of the physical environment and how they affect student engagement and inclusion, with the goal of answering the guiding question, “What do teachers need to know about how the physical classroom environment impacts student engagement and inclusivity?” A thorough literature review summarizes the most current studies related to the physical environment and its impact on students, specifically in the areas of classroom seating, arrangement, wall colour, and ambient conditions. The key take-aways from this literature review have been included in an educational website that I have developed for teachers. The website provides recommendations and evidence-based practices in simple, jargon-free language for educators. More detailed information related to the studies that support these recommendations has also been provided on the website.

https://classroomenvironment.squarespace.com/

Keywords: classroom environment, physical classroom environment, built environment, evidence-based practices, universal design for learning, inclusion, engagement, learning, learning spaces, place
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Dedication

For my students.
Contents

Abstract ............................................................................................................................................. 3
Acknowledgements .......................................................................................................................... 4
Dedication ......................................................................................................................................... 5
List of Figures .................................................................................................................................... 8
Chapter One: Introduction ................................................................................................................ 9
  Connection Between the Classroom Environment, Inclusion, and Engagement ....................... 10
  Personal Context and Rationale for the Project ............................................................................ 13
  Guiding Question .......................................................................................................................... 14
  Project Overview .......................................................................................................................... 14
Chapter Two: Literature Review ...................................................................................................... 16
  Historical Development ................................................................................................................ 16
  Policy and Curriculum .................................................................................................................. 22
  Summary of Research in the Field ............................................................................................... 23
Chapter Three: Considerations for the Design of the Website .................................................... 63
  Overview of the Website ............................................................................................................... 63
  Justification for the Creation of a Web-Based resource ............................................................... 65
  Challenges ...................................................................................................................................... 69
Chapter Four: Reflection and Conclusions ...................................................................................... 71
  My Journey .................................................................................................................................... 71
  Summary of Findings .................................................................................................................... 74
  Discussion ....................................................................................................................................... 74
  Limitations ...................................................................................................................................... 75
References ......................................................................................................................................... 78
List of Figures

Figure 1. Bronfenbrenner’s model of Ecological Systems......................................................... 18
Figure 2. Guerin’s Human Ecosystem Theory Applied to Students with ASD......................... 20
Figure 3. The Colour Temperature Scale.................................................................................. 37
Figure 4. Maximizing Colour Contrasts Between Surfaces...................................................... 40
Figure 5. The Visual Difference on the LRV Scale................................................................... 41
Figure 6. An Example of a Flexible Learning Space................................................................. 44
Figure 7. A Self-Regulation Space in the Corner of a Classroom............................................. 56
Figure 8. A Self-Regulation Space Sectioned Off with Shelving............................................. 56
Figure 9. A Self-Regulation Space Made in a Separate Room................................................ 57
Physical and built environments are where we live, work, play, and learn. These environments can significantly impact both mental and physical health, and can influence feelings of safety, comfort, and security (National Research Council, 2016). In the context of education and the classroom, the physical environment refers to the man-made aspects and surroundings in the classroom. The key aspects of the physical classroom environment include ambient conditions, such as temperature, acoustics, odor, and air quality; spatial layout and functionality, including seating arrangement, equipment, and furnishings; and signs, symbols, and artifacts (Han et al., 2019). There is a demonstrated connection between the environment of the classroom and student wellbeing and learning, but this relationship is still underexplored (Hughes et al., 2019). The classroom is the most important environment for school-aged children, and it is essential that the make-up of these environments is understood so that informed decisions can be made that will create conditions to optimize inclusion and engagement (Brännström et al., 2021). Furthermore, the issues students with learning exceptionalities experience with the physical environment of the classroom are often exacerbated (Matin Sadr et al., 2017). This needs to be taken into consideration, especially given the recent push for classrooms that put an emphasis on inclusion and acceptance.

Inclusion refers to “the process of improving the participation of individuals and groups in society and improving the ability, opportunity, and dignity of those disadvantaged on the basis of their identity” (Chennat, 2019, p. 39). As a result, an inclusive classroom is a classroom where all students are supported intellectually, emotionally, and academically, regardless of their needs, impairments, or exceptionalities. “An inclusive community respects differences among its members and embraces the means of enhancing the well being of every member of the
community” (Chennat, 2019, p. 39). Inclusive classrooms are essential for the learning and development of all students.

**Connection Between the Classroom Environment, Inclusion, and Engagement**

The physical or built environment has been studied from many different viewpoints. Whether it is the impact an office space has on workers, how the design of a household affects its residents, or how the layout of a city influences quality of life, this topic has been approached through many different lenses. However, there is seemingly less literature focusing specifically on how the physical environment relates to student engagement and inclusion. Student engagement can be defined as “the heightened simultaneous experience of concentration, interest, and enjoyment in the task at hand” (Shernoff, 2013, p. 12). Additionally, Cooper (2012) defines classroom engagement as “patterns of action reflecting acceptance of and commitment to the learning goals and expectations of success in a given class” (p. 484). There are three different, but interrelated, dimensions of engagement: behavioral, cognitive, and emotional. Cognitive and emotional engagement refer to the extent to which students value and connect with classroom activities. Behavioral engagement is the observable and physical act of students participating in academic activities and learning (Macklem, 2015).

A common criticism of the current public-school system is that it still too closely resembles the factory model of education. Quite often, students are placed in grades according to age, they sit in organized rows of desks with dozens of other students, and they work their way through successive grades. Historically, educational settings have been “grounded on industrial assumptions. Children marched from place to place and sat in assigned stations… The most criticized features of education today are the regimentation, lack of individualization, the rigid systems of seating, grouping, grading and marking” (Toffler, 1970,
This structure is no longer the most beneficial system for learners and does not reflect the direction that education is moving in. When setting up comfortable environments at home, do we use hard plastic chairs? Fluorescent lights? Individual seating where we cannot communicate with others? For most people, the answer to these questions would be no. We make use of comfortable seating and couches, we control the brightness and proximity of our lighting, we listen to music, and we decorate our spaces with plants and paintings. We do these things because they make us feel comfortable and relaxed; they allow us to think creatively and focus on our work. We need to bring this same approach and way of thinking to our classrooms. Traditional classrooms are set up with a fixed arrangement, constraining teaching and learning to one-way, linear flows, which is not consistent with the recent shift in education to student-centered learning (Neill & Etheridge, 2008). A recent survey of 21,678 high school students in the U.S. found that nearly 75% of students’ feelings related to school were negative (Moeller et al., 2020). Though this survey wasn’t strictly focused on the classroom environment, students reported feeling unengaged and uncomfortable, both feelings that have been directly linked to the physical environments of schools (Fisher, 2001).

Similarly, a 2020-2021 student satisfaction survey in British Columbia where students were asked if they felt welcome at their schools, 64% of students answered, “many times” or “all of the time”, while 55% of Indigenous students answered, “many times” or “all of the time” (“B.C. Public School Results”, n.d.). Again, though the experience of feeling welcome at your school goes beyond the physical environment, we cannot ignore the role that it does play. Changes in how we structure the environments in our schools could certainly make a difference for the 36% of students and 45% of Indigenous students who currently aren’t feeling welcomed.
Physical environments can be sources of social stress, as they create opportunities for shared experiences with others, whether positive or negative. This is especially true in schools. “Social stress is a psychological and biological pressure that stems from one’s relationship with others in social environments, which has become the most serious humanitarian issue today” (Pourbagher et al., 2021, p. 189). Learning environments have been shown to be one of the most important factors for reducing or increasing social stress and concentration (Pourbagher et al., 2021). Concentration can be understood as “the amount of focused time that a person can spend on a task without becoming distressed. Attention or concentration is important for the achievement of one’s goals according to most educators and psychologists” (Pourbagher et al., 2021, p. 190). Safe and accessible environments can help to promote inclusivity through shared experience (Winter & O’Raw, 2010). Structuring the classroom environment to support all children begins with the design of the physical space. It is important to remember that “integration — simply placing children in the same space together — isn’t inclusion” (Inclusion BC, 2017, p. 3). One way we can work towards inclusion in our schools is through creating thoughtful and purposeful classroom environments.

Research has also shown an association between the physical environment of the classroom, well-being, and learning, but the interrelationship between these concepts is underexplored (Hughes et al., 2019). This is particularly concerning for students with learning, attention, and/or sensory difficulties, as there are demonstrated benefits that alterations of the physical environment can have for these students (Matin Sadr et al., 2017; Reyneke & Hoosain, 2020; Schilling & Schwartz, 2004). A review of literature by Martin (2016) found that when the designs of classroom environments for children with Autism Spectrum Disorder (ASD) are being considered, a heuristic approach is common. “Decisions are being made based on anecdotal
information and normative design principles; with design solutions springing from ‘reasoning that is too biased by prior opinion and prior belief’, versus being grounded in a foundation of evidence-based strategies” (Martin, 2016, p. 292).

Though there is more time and effort going towards designing inclusive learning environments, there is still a limited understanding regarding how students with exceptionalities are influenced by the physical space of the classroom (Matin Sadr et al., 2017). My goal with this project is to help educate teachers in regard to important aspects of the classroom environment and help to reduce these feelings of discomfort and lack of engagement that students are experiencing.

**Personal Context and Rationale for the Project**

Though in recent years there has been a focus on inclusive classroom environments, it seems to me that there is still a lack of easily accessible resources for teachers who want to learn about the impact physical environments have on student inclusion and engagement. In my experience, there seems to be a gap between what the research says about the environmental factors that impact learners, and what is being implemented in our schools. Through my research, I have discovered that there is a lot of literature demonstrating the significance of school environments. Based on my own professional experiences and a thorough review of literature, my project explored the following guiding question: What do teachers need to know about how the physical classroom environment impacts student engagement and inclusivity? I decided to design a website offering useful, evidence-based practices for those teachers who want to learn about how they can start revamping their classroom environments to be more engaging and inclusive. The idea of classroom inclusion is challenging teachers to meet the needs of students with and without exceptionalities, though
some recent research suggests that few teachers are making use of researched-based practices in their classrooms (Martin, 2016; Neill & Etheridge, 2008). Such a gap between research and practice is concerning for students with exceptionalities, and for that matter, all students, when it is known that purposeful learning environments directly impact student behavior, engagement, and skill development (Neill & Etheridge, 2008).

Mazurek and Winter (2015) asserted that “the beliefs and attitudes of teachers are a powerful force that either promotes and advances or impedes and obstructs reform” (p. 649). Teacher attitudes and self-efficacy are improved through effective professional development and resources that provide teachers with concrete examples derived from critical research. “Critical research must be accessible by teachers and be written in a form that is easily understandable and not written for research audiences” (Hirschkorn & Geelan, 2008, p. 7). My website will help make this a reality. It is my hope to one day extend this project beyond just the website and turn it into a Pro-D presentation that I use to further spread understanding of the physical classroom environment.

**Guiding Question**

Based on the issues I have identified; my project explored the following guiding question: What do teachers need to know about how the physical classroom environment impacts student engagement and inclusivity?

**Project Overview**

As the physical classroom environment is so crucial to engagement and inclusion, I have developed a website that will help inform educators and change the way they are setting up their classrooms. My website offers evidence-based information and practices that teachers can use to create more inclusive environments at their schools. This information stems from the literature
review I have conducted in relation to the physical classroom environment. This literature review focused on numerous elements of the classroom environment such as alternative seating options, lighting, the use of flexible learning spaces, plants, acoustics, music, wall colour, seating arrangements, and the use of self-regulation spaces. Recommendations for all of these various elements of the classroom can be found within the website. The website is organized into sections, with each section focusing on one element of the physical classroom environment. Within each section, educators can find research-backed recommendations and examples for changes they can make in their own classrooms. Beyond recommendations for evidence-based practices, the website will also provide information on how to create certain classroom resources or provide links to where products can be purchased. Chapter Three provides a more detailed breakdown of the website, as well as a justification for why I created a web-based resource. It is my hope that my website will be a valuable resource to teachers who want to learn about how they can start revamping their classroom environments to be more engaging and inclusive. It will provide them with useful, evidence-based practices that they can incorporate into their own classroom preparation.
Chapter Two: Literature Review

This chapter provides an overview of the literature, both past and present, that informs the understanding of the physical classroom environment and its effect on student engagement and inclusion. Early theoretical frameworks such as Edward T. Hall’s (1966) theory of proxemics, Deci and Ryan’s (1985) self-determination theory, and Csikszentmihalyi’s (1990) conceptualization of flow experiences are reviewed and provide foundational knowledge in the field. An in-depth review of current research related to the physical classroom space is also provided. The review is focused on several different topics related to the classroom environment such as classroom arrangement, dynamic seating, lighting, acoustics, and more. Attention is given to what we currently know and what we still need to investigate.

Historical Development

Our built environments have been analyzed for a long period of time. In 1922, Winston Churchill stated that “There is no doubt whatever about the influence of architecture and structure upon human character and action. We make our buildings and afterwards they make us. They regulate the course of our lives” (Covenant University, n.d.). The study of physical space and its relationship with humans spans several decades through many different fields. Going back to 1928, Austrian architect and engineer Franz Löwitsch published the article “Sensation of Space and Modern Architecture” (Poppelreuter, 2012). Löwitsch (1928) offered an explanation of the symbolic meaning of western architecture, and how it reflects the psychological conditions of a particular time and culture. He argued that spatial sensations produce spatial concepts and equip the inherited memory of spatial sensations with pleasurable or unpleasant emotions. After the publishing of his article, Löwitsch (1928) called for an institute of Raumwissenschaft (“Science of Space”) that would examine which aspects of architecture
would be beneficial for the inhabitants of the building. The idea was that the institute would dedicate as much time and effort to the quality of life for the inhabitants as was previously put into the scrutiny and testing of building materials to verify the endurance of the building (Poppelreuter, 2012). Edward T. Hall (1966) made a notable contribution to the field with his theory of proxemics, examining the way humans and animals make use of space in two dimensions: distance and territoriality, and how people use physical distance based on emotional states. He also studied the use of space within the context of culture. Hall’s work with proxemics inspired two more theories related to how space is used. In the 1960’s, Michael Argyle developed the equilibrium theory, which stated that people would adjust their physical proximity within a space to achieve a shared level of intimacy in communication (Bailenson et al., 2001). In the late 1970’s, the expectancy violation model, proposed by Judee Burgoon, examined personal distance and how an intrusion of personal space violates the expectations of others (Bailenson et al., 2001).

In 1977, Bronfenbrenner's ecological systems theory proposed that development is a complex process that is impacted by the various environments that surround children (see Figure 1). These environments are broken down into a microsystem, mesosystem, exosystem, and a macrosystem, organized in a structure based on how much of an impact they have on a child (Bronfenbrenner, 1977). Bronfenbrenner would argue that we need to look not only at a child's immediate relationships and environment, but also at how the broader environments in their lives also interact with their development. These broader environments include things like mass media, societal beliefs and ideologies, and socioeconomic status. The microsystem refers to the environments and people that have the most direct contact and influence on a child such as their parents, teachers, classmates, their home, and their school.
Lefebvre (1991) made an interesting contribution to the field of physical space with his book, *The Production of Space*. He argued that space is a social product that has an impact on our social practices and perceptions. Deci and Ryan’s (1985) self-determination theory is a
significant foundational piece when studying the built environment of classrooms. The self-determination theory suggests that individuals are motivated to grow and develop by three universal psychological needs. These three innate needs are competence, connection, and autonomy. If these three needs are met, people can become self-determined. The connection to physical space comes through the idea that a well-designed physical space can create an environment that fosters competence, connection, and autonomy, which according to the self-determination theory, will lead to increased motivation to engage, learn, and grow (Kariippanon et al., 2018). In effectively designed learning environments, students are often given more autonomy to self-direct their own learning and make use of their space throughout the lesson. Competence is increased as more personalized and targeted instruction occurs, which can lead to peer teaching, which is also correlated to intrinsic motivation (Deci & Ryan, 1985). Finally, connectedness increases as the environment and the flexible use of space allows authentic relationships to grow between teachers and students. The environmental preference theory by Kaplan and Kaplan (1982), examined how people evaluate their environments relative to survival instincts. Their model discusses the necessary balance between making sense of our environment, while also being engaged within that same environment. We should be able to navigate and make sense of our environments, but they should not be overly legible and coherent or else they become boring; they should offer some level of engagement and stimulation (Kaplan & Kaplan, 1982). The human ecosystem (HES) theory by Guerin (1992), identified the interaction between people and their environments and the influence they have on each other (see Figure 2). More specifically, he applied this model to the classroom environment for children with ASD.
Csikszentmihalyi (1990) conceptualized the idea of flow experiences and described flow as “the way people describe their state of mind when consciousness is harmoniously ordered, and they want to pursue whatever they are doing for its own sake” (Csikszentmihalyi, 1990, p. 18). Learning in the school setting depends on students being able to reach a flow state, or at least experiencing learning in a way that is nearly equivalent with flow. Reaching a state of flow is connected to the physical environment of the classroom. As Shernoff (2013) stated, “Therefore, if schools are not created as places where individuals can regularly experience flow, it also follows that they are not set up to regularly experience learning” (p. 12).

Research related to the effects that the classroom environment has on students spans decades. Treichel (1974) conducted early research on the impact of lighting in the classroom and
suggested that fluorescent lighting could enhance hyperactivity in school-aged children. In a similar study, Colman et al. (1976) found that children with ASD engaged in more repetitive behaviors when their classrooms were lit by fluorescent lights. Boray et al. (1989) aimed to determine how different types of lighting could impact things like cognitive performance, room attractiveness, perceived room size, and pleasure of room. They were not able to find a significant difference among all dependent variables in relation to different types of lighting. They did conclude administration prefers warm / cool light over full spectrum light because they are less costly to purchase and maintain.

Zifferblat (1972) examined the relationship between classroom design and behavior in two third-grade classrooms. He noted that differences in attention and behavior observed were due to differences in the way the physical space of the classrooms were arranged. The classroom where higher attention and more desirable behaviors were observed was set up in a more open way that allowed students to more easily communicate and work together. Shapiro (1975) investigated the impact that classroom spacing and density had on students, and found that off-task behavior was more common in classrooms where there was less space per student in the room. Rosenfield et al. (1985) analyzed how desk and chair arrangement could influence student behavior. Desk arrangements used in this study of elementary aged children included clusters, rows, and circles. Using these various desk arrangements, observations were made for on-task behaviors, such as hand-raising, discussion comment, questioning/pupil request, listening, out-of-order comment, and speaking; and on their off-task behaviors, such as disruptive conduct, withdrawal, and aggression. Results showed that students seated in circles showed the most on-task behavior, while the least effective arrangement was desks assembled in rows. Nober and
Nober (1975) showed that tasks presented in a classroom with a tape recording of 65 dB representative classroom noise playing in the background adversely affected task performance.

Many of these early studies paved the way for the current examinations of how the physical classroom environment impacts student engagement and inclusion.

Policy and Curriculum

According to The British Columbia (BC) Government website, the vision of the province of British Columbia is “to provide inclusive and responsive learning environments that recognize the value of diversity and provide equity of access, opportunity and outcome for all students including students with disabilities and diverse abilities” (Province of BC, 2022, para. 1). A great place to start in making this vision a reality is with the physical environments that students are learning and growing in. Because our schools include students of varied backgrounds and abilities, the new curriculum in BC encourages teachers to make decisions that support inclusion and accessibility for all students (BC Curriculum, 2022). A student’s learning and wellbeing are intrinsically linked, and both are tied to the classroom environment (Hughes et al., 2019). If teachers in BC are going to support inclusion, equity, and accessibility, this support needs to be built upon a solid base, that starts with the physical space that students occupy. Furthermore, core competencies that “underpin the curricular competencies in all areas of learning” and are “directly related to the educated citizen” (B.C. Curriculum, 2022, p. 1), form an integral part of the curriculum in British Columbia. These Core Competencies are sets of intellectual, personal, and social and emotional proficiencies that all students are developing throughout their years in school. Core competencies associated with knowledge, skills, and process in areas such as creative and critical thinking, communication, and personal responsibility are all impacted in some form by the physical classroom environment (Blume et al., 2019; Gochenour & Poskey,
Summary of Research in the Field

I have organized this section of the literature review into subheadings based on the various elements that make up the physical classroom environment, starting with alternate forms of seating.

**Dynamic Seating**

Dynamic seating allows the user to engage in movement within the seating system. Dynamic seating options are becoming more commonly used in classrooms, especially as a strategy to use with learners experiencing attention or sensory difficulties. Some types of dynamic seating include stability balls, wobble stools, rocking chairs, standing desks, and inflatable cushions (Reyneke & Hoosain, 2020). Dynamic seating and the impact it can have for school-aged children with exceptionalities has been an interesting focal point for some recent research studies. These studies are showing promising evidence in favor of including dynamic seating in the classroom. The following research studies aimed to determine the potential benefits that dynamic seating, mainly therapy balls, can have for children with exceptionalities. Children with exceptionalities such as Autism Spectrum Disorder (ASD) and Down Syndrome (DS) exhibit inattention and distractibility more often than neurotypical children. This commonly leads to struggles at school, particularly with things like class participation, class engagement, attention, and inappropriate behaviors that hinder their ability to appropriately engage in educational activities (Matin Sadr et al., 2017). Dynamic seating is showing potential as an effective intervention to help students with exceptionalities in the classroom setting.
A study from Krombach and Miltenberger (2019) used a multiple baseline design and duration data to investigate the effectiveness of the introduction of stability ball seating for children with ASD. A second study (Matin Sadr et al., 2017) involved 15 students with Autism Spectrum Disorder (ASD). The goal of this multiple treatments study was to determine if therapy balls and air cushions could have a positive impact on sitting and on-task behavior. A third study from Reyneke and Hoosain (2020) wanted to determine if the use of stability balls as chairs would influence classroom behavior and task performance in learners with Down Syndrome (DS). The participants in the study included three learners, aged 10-12 years, with Down Syndrome. A single-subject withdrawal design was used within a special education classroom. The results of all three of these studies showed positive changes in behavior and/or engagement with the introduction of dynamic seating.

The study from Krombach and Miltenberger (2019) aimed to investigate the impact that an intervention in the form of stability balls as an alternative seating method would have for children with ASD. Specifically, the researchers used a multiple baseline design and duration data to determine the impact of the dynamic seating on in-seat and attending behavior. In-seat behavior was defined as any part of the participants’ buttocks staying in contact with the ball while also keeping at least one foot in contact with the floor. Attending behavior was defined as the participant being oriented towards the therapist or the appropriate task and materials, appropriate interaction with the materials, responding to the speaker, or looking at the speaker. The study took place in the homes of the children where they had previously been taking part in therapy sessions while seated in regular, plastic chairs. The participants were four children with ASD between the ages of 4 and 12. All four of the participants had demonstrated difficulty with seated tasks and remaining seated for more than 5 minutes during their therapy sessions.
Baseline data was obtained with observation of the participants in their regular therapy sessions with no changes in seating. In the intervention phase, which lasted for 15-20 weeks, the regular seating was replaced with a therapy ball that was individually sized to each participant. A video camera was set up to observe the participants’ faces and seating positions, and a phone app called “Tracing Pro” was used to record and track target behaviors. The resulting data showed that there was a considerable improvement in the target behaviors for all four of the participants during the intervention. The participants could partake in self-stimulatory behavior by bouncing in the seats, though this did result in all of the participants falling off of the ball at least once. There were no injuries as a result of any of the falls. The extended data collection period and sustained changes in behavior helped to demonstrate that the improvements observed were not a result of novelty of a new type of seating. “The improvement in behavior was maintained over time and occurred regardless of student age or functioning level” (Krombach & Miltenberger, 2019, p. 555). The limitations I noted with this study included a small sample size, the environment not being similar to a classroom, no noted orientation or instruction related to the new type of seating, and that the study did not assess arousal or sensory processing in relation to the effectiveness of the dynamic seating. However, this is the first study to examine the impacts of dynamic seating in an at-home, therapeutic setting for children with ASD. The diverse range of ages and length of the study were advancements upon similar prior research.

Another study related to dynamic seating (Matin Sadr et al., 2017) involved 15 students between the ages of 7 and 10 with ASD at Mashhad’s Tabasom School in Mashhad, Iran. Participants were selected with a convenience sample. The goal of the study was to determine if therapy balls and air cushions could have a positive impact on sitting and on-task behavior for the 15 students with ASD. The study was carried out by having student behavior video recorded
in three different phases over the course of eight weeks. Phase A used their regular classroom seats, phase B was with therapy air-cushioned seats, and Phase C used therapy balls for seats. To account for the novelty of a new type of chair, students were oriented to the new types of seating for two days before baseline data gathering began. On-task behavior and in-seat behavior were both measured, meaning that they collected data for on-task behavior whether a student was standing or sitting. On-task behavior, whether standing or sitting, was described as behavior “oriented towards appropriate classroom activity or teacher and either interacting with materials, responding to the speaker or looking at the speaker” (Schilling & Schwartz, 2004, as cited in Matin Sadr et al., 2017, p. 31). When using the therapy balls for seats, the results of the study showed a positive increase in on-task behavior while sitting in 86.7% of the students, and an increase of on-task behavior while not sitting in 53.3% of the students. The air-cushions had no significant effect on behavior. The therapy balls also showed a decrease in self-stimulatory behaviors and an increase in communication (Matin Sadr et al., 2017). This study showed some promising results for using alternate seating for students with ASD. Teachers from the study also reported that students seemed calmer, which could be attributed to the ability to gently rock or bounce in their seats. I did note some issues with the study. The sample size was quite small (15 students), and the study only lasted for eight weeks. Matin Sadr et al. (2017) noted a decrease in self-stimulatory behavior, as well as improved communication, but this didn’t seem to be quantified, and there was little to no discussion of the observed improved communication in the discussion section.

An Occupational Therapist in private practice and a Lecturer for the Faculty of Medicine and Health Science at Stellenbosch University in South Africa (Reyneke & Hoosain, 2020) aimed to determine if the use of stability balls as chairs would influence classroom behavior and
task performance in learners with Down Syndrome. The participants in the study included three learners, aged 10 to 12, with Down Syndrome. A single-subject withdrawal design was used within a special education classroom. The study incorporated five phases in total over the course of six months. Two phases incorporated regular classroom chairs, while three phases incorporated the stability balls as chairs. The researchers also included a novelty phase over the course of a month so that the students could become accustomed to the new seats. Classroom behaviors that were measured included in-seat (chair/ball), out of-seat, on-task, and off-task behavior. Data was collected via direct classroom observation as well as with a questionnaire for parents. Results showed that the use of the stability balls as chairs led to a notable positive change in the learners’ on-task performance (Revneke & Hoosain, 2020). Improvements were observed in all three of the learners involved in the study with the implementation of the stability balls. When the students returned to their regular chairs, researchers observed a decline in on-task behavior. All participants and educators reported a positive outlook towards the stability balls as an alternate form of seating. A limitation of the study was the relatively small sample size of three students. Despite the small sample size, this study provides further evidence for the positive effects of dynamic seating in the classroom. The stability balls provided a mechanism that allowed for rocking, bouncing, or swaying, which gives learners the chance to self-regulate. Self-regulation involves planning, persistence, and thinking about one’s actions. It is the process of monitoring your own thoughts, feelings, and behaviors. Self-regulated students show the capacity to engage in the classroom, as well as choose learning strategies that work for them. They are able to adapt or change strategies when situations become challenging, and their current strategies aren’t working (Macklem, 2015). This ability to self-regulate can lead to a decline in off-task behaviors in the classroom.
Gochenour and Poskey (2017) completed a literature review analyzing the effects that an alternative seating system can have on improving attention in students with attention difficulties. The authors did not conduct a study, but rather, they collected articles from peer-reviewed journals, compiling and critically appraising the information that they found. They only used articles that focused on students with attention difficulties, made use of alternative seating systems, and used attention levels in class as the outcome measure. Research showed that many students who have Attention Deficit Hyperactivity Disorder (ADHD) demonstrate difficulties detecting sensory input, modulating sensory input, and/or interpreting sensory input (Ghanizadeh, 2011, as cited in Gochenour & Poskey, 2017). This can have an impact on behavior at school. Alternate seating (e.g., therapy cushions, therapy balls, wobble stools, etc.) in a classroom has been shown to allow students with ADHD an opportunity to seek sensory input in a way that is appropriate for school and on-task behavior (Gochenour & Poskey, 2017). With alternative or dynamic seating being used, 66% of the articles measuring in-seat behavior showed an improvement in attention, while 50% of the articles that measured on-task behavior demonstrated an improvement in attention (Gochenour & Poskey, 2017). Teacher and student preference for using alternate seating varied by study, though the majority approved of the seating and did not find it to be a distraction. The authors concluded that their review demonstrated positive benefits of alternative seating for students who have difficulties focusing in the classroom. Providing students with a type of seating that allows for personalization and movement is beneficial to all students in a classroom, and it can create a more inclusive environment by giving students with attention difficulties an opportunity to seek sensory input that improves classroom behavior.
It seems that students with ASD, DS, and attention difficulties, who benefit from an opportunity to seek sensory input, experience positive results from alternate seating options in their classrooms. There is a consistent improvement in attending, on-task, and in-seat behavior for these students when offered a dynamic seating option. A common observation is that participants can regulate their sensory input in a non-disruptive way by bouncing, swaying, or rocking in their seats. The information from these studies provides valuable insight into how we can use seating as a tool to create more inclusive classrooms. I believe more research should be carried out to investigate why exactly these forms of dynamic seating have a positive influence on classroom behavior. Schools have used traditional types of seating for a very long time, mainly due to convenience and cost. The findings from these studies show that it is time to start considering alternate forms of seating as a more common option for students in classrooms if the goal is to create more inclusive environments for learners with a diverse range of needs.

**Classroom Seating Arrangement**

Student seating location is something that most teachers think about and plan for, especially when they are teaching students who are particularly inattentive or hyperactive. A well-designed seating plan and arrangement can make classrooms more inclusive, engaging, and can minimize negative impacts on vulnerable learners. A study from Blume et al. (2019) was recently published in the international, peer-reviewed journal *Learning and Instruction*. The study was completed by six researchers from the University of Tubingen, Germany. The goal was to investigate whether student seating proximity to the teacher had a positive effect on learning. The study also aimed to take individual levels of inattention and hyperactivity-impulsivity (i.e., ADHD symptoms) into account. The 81 participants involved were grade 5-6 students (average age of 11.27 years) who all experience ADHD symptoms to varying extents,
though only two of the students had actually been diagnosed with ADHD (Blume et al., 2019). The level of ADHD symptoms for each student was assessed using a standardized questionnaire that was filled out by a parent. The learning for the study took place during a virtual reality math lesson where participants had to learn a new concept that wasn’t part of their regular curriculum. Within the virtual reality classroom, students were randomly seated at varying distances from the teacher. The visibility of the lesson wasn’t an issue from any distance, as all students had normal or corrected-to-normal vision. Students attended the session to connect to the virtual classroom in a quiet place at their own school or at the University. The virtual reality classroom adapted the volume of the teacher depending on how far away the students were sitting. Distracting events like doors opening, paper airplanes flying by, and peers talking took place at random. After the lesson, students left the virtual classroom to complete a task with what they had learned, and their work was assessed to see how well they understood the concept (the taught solution strategy). The results of the study demonstrated that seat location significantly affected the learning of the taught solution strategy. Students sitting closer to the teacher learned notably better than those sitting further away. As predicted, students with more significant symptoms of ADHD showed less of an understanding of the taught solution strategy. However, the findings of the study showed that sitting closer to the teacher did not differentially promote learning as a function of individual ADHD symptoms. The results suggested that children with more significant ADHD symptoms experienced a larger decrease in learning in the distant seat locations than the students with less severe ADHD symptoms. This was the first study that assessed seat proximity and learning while considering student ADHD symptoms. This is a promising area of research, as studies have shown that students with ADHD have more difficulties learning in the classroom environment (Anderson et al., 2012; O’Regan, 2019), so
anything that can be done to make our classes more inclusive of learners with ADHD is great. This study was potentially limited by the fact that it took place in a virtual environment as opposed to an actual classroom.

A study from van den Berg and Stoltz (2018) aimed to determine if the seating arrangement of a classroom can promote social acceptance and prosocial behavior in students with externalizing problems. Students with externalizing problems are at higher risk of being excluded by classmates, which can potentially lead to more serious and chronic externalizing problems. The study also aimed to limit any possible negative consequences for classmates who were sitting next to the students with externalizing problems. A total of 1,569 students in 28 schools across the Netherlands participated in the study (van den Berg & Stoltz, 2018). The average age of the students was 10.45 years and 50.3% of them were male. Of these participants, 221 target students were selected by teachers based on their higher levels of externalizing behavior at school. The majority of this target group was male (80.2%). “Buddies” were identified by peers as well-liked students at the top of their classes or who demonstrated prosocial behavior. A pretest (before the intervention) where teachers and students completed questionnaires, showed that the target students were more aggressive and less prosocial. Teachers also provided a map of their default seating arrangement during the pretest phase. The measures of the study were likeability (peer report), externalizing behavior (teacher report), and aggressive and prosocial behavior (peer report). The research team designed new seating arrangements after the pretest. In the control condition, target students were seated at random, while in the experimental condition, target students were placed next to “buddies”. This new seating arrangement was kept in place for an average of 10 weeks, at which point the post-test took place. The post-test consisted of teacher and student questionnaires. The results of this study
demonstrated that after the new seating arrangement, the target students were more liked by their peers and showed fewer externalizing problems (van den Berg & Stoltz, 2018). Classmates who sat next to students from the target group did not become more aggressive or less prosocial during the 10-week implementation period. The only negative impact they experienced was a slight decrease in social status. Seating students with externalizing problems is not an easy task for classroom teachers. This study has shown, however, that taking time to carefully arrange a seating plan that seats students with externalizing problems next to prosocial and well-liked peers can promote peer acceptance and decrease externalizing problems.

Desk and table arrangement will no doubt have an impact on the behavior and engagement of students within a classroom. Simmons et al. (2015) conducted a study to compare the impact that different types of seating arrangements had on second graders while completing independent work in a classroom. The three types of seating arrangements compared included cluster seating, horseshoe seating, and traditional row seating. The off-task behaviors that were observed included inappropriate talking, students out of their seats without permission, students not following directions, and students not starting independent work promptly. Results showed that the row seating arrangement had the fewest off-task behaviors and was determined to be the best arrangement in this classroom setting. Simmons et al. (2015) also noted, however, that based on previous research, cluster seating and horseshoe seating have benefits as well. Cluster seating, which is comparable to table seating, has been shown to be effective for collaborative learning and for increasing social interaction and participation in class discussions. It also helps to foster more peer assistance. Despite these benefits, it has also been shown that cluster seating increases off-task behaviors. Horseshoe seating, in which desks are arranged more closely to the perimeter of the classroom in a horseshoe shape, can lead to more off-task discussion between students, but
also allows lessons to be more engaging. This arrangement can also encourage student participation in class activities and discussions. This is consistent with the findings from a study by Yang et al. (2021), who used a questionnaire to survey 94 first-year college students on their preference for seating arrangement with respect to cooperative learning within the classroom. A semicircular seating arrangement (similar to horseshoe arrangement) was found to be more effective at integrating students into cooperative learning activities than the more traditional row seating. Students, after having experienced both semicircular and row seating, showed a preference for semicircular seating, as they perceived it to be “more humane, active, convenient and inclusive” (Yang et al., 2021, p. 1369).

A book from Salen (2015) titled *Creating Inclusive Classrooms: Effective and Reflective Practices*, includes a number of recommendations on how to arrange classroom seating to promote inclusion. Salend (2015) recommended using different types of seating based on the classroom activity. Traditional, teacher-led instruction is best suited to desks arranged in rows. A horseshoe arrangement can also be used in this situation, especially if the teacher wants to incorporate class discussion into the instruction. If students are doing group work, desks can be put together into clusters so that they can directly share information. If a class includes students with hearing impairments, they should be placed in a central location about two rows from the front where they can see the teacher’s and other students’ lips. If possible, it also beneficial to have students with hearing impairments in swivel chairs. This allows them to easily move and follow along with conversations as they orient themselves to the speaker. Using a staggered seating arrangement can also ensure that these students can have a direct view of whoever is speaking. Teachers should also be mindful to seat hearing impaired students away from structural noises such as those of heating and cooling units. For visually
impaired students, there are several adaptations for teachers to consider when planning their classroom arrangement. Visually impaired students should sit in areas that will be glare-free and well-lit. Their workspaces should not be facing any classroom windows and they should not have to look directly into a light source to see the teacher. Their location in the room should offer an unobstructed view of instructional activities and a direct path to major parts of the room. For students with physical disabilities, there are numerous barriers to inclusion that can be encountered in regard to classroom seating arrangement. Students who use wheelchairs, prostheses, or crutches need at least 32 inches of space between desks, doorways, and furniture. This allows them to move about the classroom easily and safely. Some students may also need an area where they can recline during the day. It is also a good idea to use ergonomic furniture that has padding on the edges and no protrusions. Chairs should have seat heights of at least 16 inches and should be sturdy enough to hold students who may need to pull up on and out of them. Though it is ideal to use inclusive furniture that works for all students, there may be situations where students with physical disabilities need a different type of chair than other students in the class. This can be necessary to allow them to sit independently and maintain an upright position in the class. Examples of such seating include corner chairs, floor sitters, and chairs with arm and/or footrests.

**Classroom Lighting**

Another aspect of the physical classroom environment to consider is the lighting of the room. “Light is a radiation or complex of electromagnetic radiations emitted by incandescent or luminescent bodies and which impresses the human eye” (Saulea, 2021, p. 37). Students visual senses are stimulated by the various types of lighting we incorporate into learning environments. Light can be natural or artificial. Natural light comes from the radiation given off by the sun,
while artificial light sources are human-made sources of light that use electricity or halogen gas to glow (Saulea, 2021). Though only anecdotal evidence, I have had many students complain to me about lighting in schools. These students referred to headaches and difficulty focusing, as well as a feeling of being generally uncomfortable. There is some research to back up these claims, as there have been numerous studies completed investigating the impact different types of lighting can have on students in a classroom. Winterbottom and Wilkins (2009) aimed to assess the extent to which students in schools in the United Kingdom (UK) are exposed to aspects of classroom lighting that have been shown to cause discomfort and impair task performance. These aspects of lighting include undetectable 100 Hz flicker from fluorescent lighting, glare caused by daylight and fluorescent lighting, interactive whiteboards and dry-wipe whiteboards, and patterns from Venetian blinds. To gather data, lighting conditions were sampled in 90 classrooms across 11 secondary schools. The sampling of classrooms was random but stratified across the buildings to ensure that the number of classes sampled was proportionate to the number of curriculum areas within the school. This ensured that the sample was representative of a student’s potential experience throughout the entire school. A sketch was made of each classroom that showed positioning of lights, desks, whiteboards, blinds, and windows. The data was collected during the Summer, which means that the daylight levels were higher than normal. Data collected was analyzed using descriptive and non-parametric statistics. Winterbottom and Wilkins (2009) were able to identify several issues related to the lighting of the classrooms that were assessed. Classrooms were over-lit with fluorescent lights that have been shown to cause headaches and impair visual performance. Lights with a lower colour temperature (3500 K) were preferred to lights with a higher colour temperature (6000 K). Classrooms were also over-lit from both fluorescent lighting and daylight. Both these types of
lighting could not be effectively controlled to a desirable level. Winterbottom and Wilkins (2009) recommended that new classrooms should have dimmable lights and blinds that are regularly maintained that can control levels of daylight in the classroom. Glare from whiteboards was also common throughout the schools. It is recommended that whiteboards be tilted away from the wall so that potential reflection is directed towards the ceiling. A positive note about the results of the study is that “In most cases, action to correct the problems would be simple, and any costs would be offset in the medium term, due to increased efficiency, reduction of wastage, and benefits in terms of health of pupils and staff” (Winterbottom & Wilkins, 2009, p. 74).

Keis et al. (2014) studied the impact that blue-enriched lighting could have on students’ cognitive performance. Their study involved 58 high school students who were recruited from two schools in Ulm. The students were all of similar age and had similar educational backgrounds and socio-economic status. In each of the schools, the lighting in one classroom was changed to blue-enriched white lighting (higher colour temperature; see Figure 3), while a classroom next door served as a control. All classrooms had similar windows that faced in the same direction, so outside influences from the weather did not create a difference between classrooms. During the intervention phases, students were exposed to the blue-enriched white lighting for five weeks during November and December. Outcomes measures included speed of cognitive processing, concentration, memory retention, and student preference. The results of the study showed increased performance in the classrooms with blue-enriched white lighting in cognitive processing speed and concentration, but not with memory retention. The authors concluded that the blue-enriched lighting seemed to influence basic information processing, as there was no effect on short-term coding and retrieval of memories. They also stated that blue-enriched lighting “acts as a zeitgeber and entrains the human circadian clock. Correspondingly,
missing short-wavelength light in the morning postpones entrainment and leads to a delay of circadian cycle of high school students” (Keis et al., 2014, p. 91). Though the blue-enriched lighting improved students’ performance with cognitive processing and concentration, students preferred the standard lighting because of the brightness, light colour, and pleasantness. Many considered the blue-enriched lighting to be too bright. This is consistent with the previously mentioned study from Winterbottom and Wilkins (2009), where lights with lower colour temperatures (3500 K) were preferred to lights with higher colour temperatures (6000 K).

Choi et al. (2019) conducted a study in which their goal was to investigate physiological and subjective responses of students to morning light exposure with different colour temperatures. The melatonin and cortisol levels of 15 university students were measured and compared after an hour of morning light exposure to both warm (3,500 K) and blue-enriched (6,500 K) white lights at recommended levels for classrooms. Perceptions of sleepiness, mood, and visual comfort were also compared. The participants had an average age of 23.35 and included eight men and seven women. All the participants were exposed to both types of
lighting, though the order in which they were exposed was randomized. Saliva samples were
taken before and after the light exposures to measure melatonin and cortisol levels. The
subjective measures of sleepiness (i.e., sleepiness, mood, and visual comfort) were rated using
the Karolinska Sleepiness Scale (KSS). Results showed that the decline of melatonin levels
associated with waking up was much greater after the exposure to blue-enriched (cooler) light
than the warmer light. The blue-enriched light also such a significant improvement in subjective
perception of alertness, mood, and visual comfort. There was no significant difference found in
cortisol levels between the two lighting conditions. These results would suggest that using blue-
enriched lighting may help students with early morning drowsiness and students with a tendency
to doze off in morning classes.

Current research has demonstrated that natural light provides “an array of physical and
mental health benefits” (Porras Álvarez, 2020, p. 4167). Positive effects of natural light also
include an enhancement of visual, emotional, and psychological well-being (Gou et al., 2013).
Certainly, many would agree that they enjoy having access to natural light in a classroom setting,
but are there benefits of natural light when it comes to intellectual performance? A case study
from Porras Álvarez (2020) carried out with 278 university students over the course of six years
aimed to determine how natural light could impact intellectual performance. The participants in
the study took a course from March to June that consisted of three, one-hour lectures. The course
was taught once per year for six consecutive years. The participants were all senior
undergraduate students between 22 and 27 years of age. The classes were all carried out on the
same campus at the same time of year so as to control any possible geographical or climatic
variations. The classes always occurred at the between 9:00 am and 11:45 am so that there could
be no variation based on alertness levels of the students. Of the six times the course was taught,
three took place in an exclusively artificially lit basement classroom, while the other three took place in classrooms that had a mix of natural and artificial light. The classes were all lit by full spectrum fluorescent lamps (6500 K) to avoid any variance in results based on the colour temperature of the lighting. The basement and window classrooms were compared with data and attendance scores. The results showed strong evidence that deprivation of natural light had a negative impact on the intellectual ability of the participants. Comparing the entire population of window and basement classrooms, the students in the classrooms with windows showed exam scores that were 13.13% better than those of the students in the basement classrooms. Even when eliminating the two years with the most extreme data (best and worse exam scores), the mean exam score for windowed classrooms was still 7.73% better. The results of this study indicate that it is beneficial to students to have windows in their classrooms that will allow for natural lighting in combination with artificial lighting.

**Wall Colour**

Closely tied to the lighting of a classroom is the colour choice for the room. The impact of colour on mood has been examined for decades. It is one of the first elements of the physical classroom that is observed upon entry, as sight accounts for about 75% of the information we receive related to our environment (CPD 6, 2018). Wall colour has been shown to affect student behavior and cognitive responses (Pourbagher et al., 2021). Previous studies stemming back to the early 90s have pointed out the connection between wall colour and the attention of users in the room, though many of these studies used adults as subjects and not youth (Baytin, 2005; Duyan, 2016; Kuller, 2009; Kwallek, 1996, as cited in Pourbagher et al., 2021). When designing inclusive classrooms, it is important to consider the impact that wall colour can have on different individuals. “There is a need to balance the benefits of color in assisting those with visual
impairments while avoiding overstimulating students who may be sensitive to environmental stimuli” (Pourbagher et al., 2021, p. 192). When considering students who may be visually impaired, designers need to think about creating colour contrast for critical surfaces (see Figure 4). Critical surfaces are the areas that would be considered the most important when trying to gather information about a space in terms of its dimensions and moving safely about the room. These would include things like doors, skirting, lighting, and obstacles within the room (e.g., furniture, desks, tables, etc.). The obvious answer to this problem would then be to maximize the colour contrast between such surfaces. Using contrasting colours such as black, yellow, and white could create stark contrasts between things like floors, walls, doors, handrails, and stairs. The problem with this is that you will create an environment that in unappealing to fully sighted users of the space, as well as a room that may be overstimulating to students who are sensitive to environmental stimuli (CPD 6, 2018).

Figure 4

Maximizing Colour Contrasts Between Surfaces

Because the majority those who are visually impaired can still distinguish colour variations, it is possible to create inclusive spaces that meet the needs of visually impaired students, while still
being aesthetically pleasing and not overstimulating to sighted students. It is recommended that adjoining surfaces have a minimum of 30 points of difference in their light reflectance value (LRV). This is enough contrast for the majority of those who are visually impaired to perceive the contrast, while not being distracting to those who are fully sighted. LRV is a 100-point scale that describes the percentage of light being reflected from the surface. 0 is black and 100 is white (see Figure 5).

**Figure 5**

*The Visual Difference on the LRV Scale*

Pourbagher et al. (2021) conducted research via a survey of 275 university students. Their aim was to determine the impact of wall colour on student stress and concentration. The main wall colours that they examined were green (cold), blue (very cold), red (very warm),
yellow (warm), and white (neutral). Wall colour was the independent variable while the amount of stress, concentration, and combination between the two was the dependent variable. According to the results, wall colour had the most significant effect on students’ stress and concentration in classrooms with flexible seating plans and furniture arrangements. Classrooms with a rigid layout and fixed seating showed the least impact from wall colour on the students. Pourbagher et al. (2021) concluded that on average, wall colour has about a nine percent effect on students’ stress and concentration across a variety of classrooms.

Yildirim et al. (2014) conducted research to assess the potential effects of different interior wall colours of classrooms on the perceptual performance of male students. A survey was used for a total of 909 students at a Vocational High School in Ankara, Turkey. The students at this school were solely male and ranged from grades 9-12. Three different types of colour were examined in this study: neutral, warm, and cool. The neutral colour was cream, the warm colour was pink, and the cool colour was blue. The results of the survey showed that the different interior colours of the classrooms had a statistically significant effect on the perceptual performance of the male students. The results showed that the blue walls were perceived the most positively. The blue walls were described as happy, roomy, peaceful, pleasant, calm, and comfortable. Despite this, the blue walls were also viewed as being less exciting and dynamic than the others. The findings of this study were consistent with previous studies, as though the blue colour elicited peaceful and calm perceptions from the students, the warm colours made the room seem smaller but more stimulating. This is an important factor to consider when thinking about students who are sensitive to environmental stimuli and may be overwhelmed by the warmer colours.
Another factor to consider when examining the impact of wall colour in classrooms is the cognitive attention and memory function of students. There is increasing evidence showing the connection between wall colour and student performance and preference, but comparatively very little regarding attention and memory. Llinares et al. (2021) conducted a study to investigate the impact that warm and cold coloured classrooms can have on cognitive attention and memory function of students. Their study involved 160 participants across 24 different virtual reality (VR) environments, 12 of which were warm colours, while the other 12 were cold colours. The effect of the different colours within the various VR environments on the participants’ attention and memory were measured though psychological and neurophysiological responses. These responses were tracked through psychological attention and memory tasks. The participants also completed a questionnaire about their sense of presence during the experiment, which refers to the illusion of “being there” during an environmental simulation. The results of this study demonstrated that the colder hue colours increased arousal and performance in both attention and memory tasks. This result can be explained “at the neurophysiological level by the achievement of a level of sympathetic system activation appropriate to the maintenance of higher alertness and cognitive performance” (Llinares et al., 2021, p. 10).

**Flexible Learning Spaces**

Flexible learning spaces are environments designed to support student-centered teaching methods and learning experiences through the use of different furniture and layouts. Furniture, technology, and equipment within a flexible learning space are adaptable and can be rearranged to best suit the learning needs of students (See Figure 6). Furniture can include things like couches, adjustable chairs, soft seating, mobile/adjustable desks and tables, flexible shelving, and
more. Flexible learning spaces are designed to offer opportunities for both individual and collaborative work (Kariippanon et al., 2018).

**Figure 6**

*An Example of a Flexible Learning Space*

Kariippanon et al. (2018) conducted interviews and group discussions with 12 school principals, 35 teachers, and 85 students from four primary and four secondary schools in Australia to gather data related to flexible learning spaces. They aimed to explore the relationship between flexible learning spaces and student-centered pedagogy, self-regulation, collaboration, autonomy, and engagement. To collect data, Kariippanon et al. (2018) used a qualitative case-study approach with one-on-one interviews, as well as group discussions. To select appropriate schools for the study, “Purposive sampling ensured that participating schools had transformed the built environment of their learning spaces” (Kariippanon et al., 2018, p. 303). Of the 12 school principals, five were from primary schools and seven were from secondary schools, and they were interviewed through eight leadership team interviews. The
teacher group consisted of 18 primary and 17 secondary teachers with a wide range of experience. Teachers participated in one of eight 45-minute focus-group discussions, which were made up of up to five teachers. The student sample included 45 primary students and 40 secondary students (47% female and 53% male). The students came from over 20 different cultural backgrounds and represented a wide range of socio-economic demographics. According to Kariippanon et al. (2018), “flexible learning spaces were reported to facilitate student-centred pedagogy and self-regulation, collaborations and student autonomy and engagement. Modified spaces were reportedly more enjoyable, comfortable and inclusive and allowed greater interaction” (p. 301). Kariippanon et al. (2018) also concluded that in order for differentiated teaching and personalized learning to take place, the classroom should not be set up in a traditional manner, but rather, in a differentiated, flexible arrangement.

Mulcahy et al. (2015) conducted a one-year study to examine learning space design and its real-world practice. Making use of a stratified sampling strategy, data was collected using video and naturally occurring interactions in classrooms, as well as interviews with seven school leaders, nine teachers, and eight students. The participants came from a secondary school in a high socio-economic area, a secondary school in a low socio-economic area, a primary school in an affluent suburb of a regional Victorian city, and a primary school in an area with a large immigrant community and low socio-economic status. All of the schools used had a “reputation for innovative pedagogic practice with regard to the ‘take-up’ of new learning spaces” (Mulcahy et al., 2015, p. 582). Their findings supported a relationist, non-duality perspective on learning spaces and educational change. Physical space and social change are something that are created simultaneously. Mulcahy et al. (2015) stated that “What we call a learning space is more than a physical building in which learning occurs” (p. 591). Rather, a learning space is “the product of
interrelations and materially-embedded practices, connected in space and time to wider flows of ideas, technologies and discourses in society’ (McGregor, 2003, pp. 368–369, as cited in Mulcahy et al., 2015). Mulcahy et al. (2015) also stated that they “see promise for the emerging field of learning spaces in thinking about space from a relational, sociomaterial perspective” (p. 575).

Kariippanon et al. (2019) carried out a school-based cross-over trial study to learn more about the impact flexible learning spaces can have on student behavior. Their study involved students from nine different secondary schools, where purposive sampling was used to identify schools that had developed at least one classroom with a flexible learning environment. Changes to the classroom included alterations to the physical environment, as well as the pedagogical approaches used in the space. The classes involved were grade 7-9 classes from 12 different public schools in Australia. Students’ behavior during class was observed using momentary time-sampling. The instrument used was based off an observational tool called the Classroom Observation System, COS-5 Pianta. The purpose of this tool is to record the frequency of a range of different behaviors and experiences that can be observed within a school classroom. Traditionally arranged classrooms and flexible learning spaces were both observed for 30-minute periods. “In traditional classrooms the approach was predominantly teacher-led and in the flexible learning space it was student-centred” (Kariippanon et al., 2019, p. 1). Students in flexible learning spaces spent significantly more time collaborating, working in groups of more than six students, actively engaging with the lesson content, and positively interacting with others than in the traditionally set up classroom. Students in the flexible learning spaces also spent less time verbally off-task, being engaged in teacher-led instruction, working independently, and negatively interacting with others. These results suggest that the combination
of flexible learning environments and student-centered pedagogical approaches could lead to beneficial learning outcomes, as students spent a higher proportion of their class time interacting, collaborating, and engaging with lesson content.

**Plants in the Classroom**

Current research suggests that indoor plants play a significant role in regulating the quality of indoor environments and can have both physical and psychological benefits for students, especially on feelings of happiness and creativity (Kim et al., 2020; Najafi & Keshmiri, 2018; Studente et al., 2016). Creativity is a difficult term to define due to its subjective nature. Cambridge dictionary defines creativity as “the ability to use original and unusual ideas” (Cambridge, n.d.). Another widely accepted definition comes from Sternberg (1993), who states that creativity is “the ability to produce work that is both novel and appropriate” (p. 1). A study from Studente et al. (2016) aimed to investigate the impact that live plants, the colour green, and views of nature have on visual and verbal creativity within a classroom setting. Visual creativity usually refers to the production of things like drawings, paintings, and photographs, while verbal creativity refers to the production of written and spoken words. The participants in this study were 108 business students from a British university. The participants within the control group worked in a classroom with no plants present and blinds that were closed to block any views to plants and natural settings outside. The first experimental group worked in a classroom with live plants and windows with views of a green area outside. The second experimental group worked in a classroom with no plants and closed blinds, but were given creativity tasks on green paper. In order to measure verbal creativity, the Alternative Uses Task (GUAT) was used. This is a method used to measure different aspects of creativity such as flexibility, fluence, and originality (Studente et al., 2016). Visual creativity was measured by having participants complete the 30
Circles Test, in which they were given a piece of paper with 30 circles on it that they need to try to incorporate into their own drawing. The aim is to make use of as many of the circles as possible within a three-minute timeline. The results of the study clearly showed that classroom features such as plants can enhance creativity among students. Views of nature, live plants, and the use of the colour green all led to increased visual creativity. These variables did not seem to have an effect on verbal creativity (Studente et al., 2016). The difference in impact on verbal and visual creativity could be due to the differences in the cognitive processing of visual and verbal information. Some research suggests that these two types of information are processed in two distinct parts of the brain. Individuals may also have a preference between visual and verbal processing. Despite the difference in impact on verbal and visual creativity, incorporating the colour green, live plants, and views of nature into a classroom set up are all ways that the visual creativity of students can be improved.

Happiness and a positive state of mind are important aspects to consider when trying to create engaging and inclusive environments. Najafi and Keshmiri (2018) conducted a study to investigate the impact of indoor plants in a classroom on the happiness of female highschool students. Happiness is an important emotion to consider when trying to create environments where students feel comfortable and are willing to be vulnerable and take risks. This study included 384 female high school students who were part of a pretest-posttest design and a control group. The students were randomly divided into intervention and control groups, with six classes (approximately 192 students) in each group. For a pretest, each group completed a demographic questionnaire and the Oxford Happiness Inventory (OHI) scale. Potted plants were placed in the classroom of the experimental group for 12 weeks and then the OHI was completed by both the groups as a posttest. Pre-test mean happiness scores were very similar for both groups, with
scores of 41.17 and 39.50 for the intervention and control group, respectively. After the 12-week intervention, the post-test OHI showed an increase in the mean happiness score from 41.17 to 55.58 in the intervention group who had plants added to their classroom. The control group saw a much smaller increase from 39.50 to 41.17. The results support the idea that incorporating indoor plants into the classroom setting can have a positive effect on the happiness of female high school students. Further research to investigate the impact on male students would be beneficial to determine if there is more evidence to support the inclusion of plants within the classroom environment.

In addition to creative thinking and happiness, there is another positive aspect of indoor plants to consider when setting up a classroom: air quality. Indoor environmental quality (IEQ) refers to the environmental quality of a building and how it relates to the health of the building’s occupants. Air quality is one major facet of IEQ, along with things such as lighting, temperature, and space management. All these factors play a significant role in student satisfaction with their learning environments (Jamaludin et al., 2017). A common pollutant found in indoor environments is VOC (Volatile Organic Compound). Previous research has suggested that plants can be used to create better air quality through reduced air pollution. Jamaludin et al. (2017) demonstrated that the placement of indoor plants in classrooms for two weeks decreased the level of relative humidity, CO2, and VOC. An improvement in air quality is significant in regard to creating a positive classroom environment, as a study from Kim et al. (2020) showed a connection between indoor plant placement in the classroom and the attention capacity of students. Seventy sixth-grade students were the participants of a study examining the impact of indoor plant placement on classrooms in two elementary schools in Seoul, South Korea. Students were separated into two groups; one group occupied classrooms without any indoor plants, while
the other group were in classrooms that incorporated indoor plants into the environment. The intervention took place for 12 weeks. After this period of time, not only did the classrooms with indoor plants have lower concentrations of airborne contaminants and more constant air temperature, relative humidity, and CO2, but the subjects within these classrooms showed improved attention capacity. Attention capacity was measured using a standard questionnaire (Frankfurt Aufmerksamkeits-Invertar, FAIR).

**Acoustics and Music**

When creating inclusive classroom environments, the acoustics and noise levels of the classroom are factors that need to be considered. While it may seem intuitive, it is important for educators to recognize that noise levels within classrooms can have a detrimental effect on students and their learning. In fact, “a significant negative relationship has been found between noise levels and learning attainment, cognitive processing, reading, and to a lesser extent, numeracy tasks” (Shield et al., 2010, p. 226). There is also evidence supporting the idea that noise can negatively impair attention, concentration, and memory. Klatte et al. (2013) carried out a review of literature focusing on the impact of noise in the classroom. Their review pointed to studies consistently showing that children’s speech perception is more significantly impaired than adults’ by unfavorable listening conditions. Children’s ability to understand speech under noisy conditions and reverberation continues to improve until their teenage years, meaning that we need to be mindful of classroom acoustics, especially with younger students. Students will require an environment with favorable listening conditions to effectively decode and process oral information. According to Klatte et al. (2013) “Non-auditory tasks such as short-term memory, reading and writing are also impaired by noise” (p. 4). Such impairments could result from interference with the student’s perceptual and cognitive processes or from a more general
attention capturing process. There is also evidence pointing to sound levels having a chronic impact on children. Though there are some inconsistencies across studies, most evidence demonstrates that environmental noise can affect children’s cognitive development (Klatte et al., 2013). Though these effects are generally shown to be small in magnitude, such long-term effects still need to be taken seriously.

A study from Caviola et al. (2021) aimed to gather a stronger understanding of how background noise can impact learning, and more specifically, math achievement. Listening conditions were manipulated within various classrooms of 162 middle school students aged 11-13. Listening conditions included quiet classrooms, classrooms with traffic noises, and classrooms with general classroom noise. The results showed differential negative effects of listening conditions on math achievement related to task difficulty and the age of the students. The youngest children performed best in the quiet classrooms, followed by the traffic noise and the classroom noise conditions, respectively. The detrimental effect of the louder classrooms was not as significant in the older children. It was also found that the higher noise levels had the most detrimental effect with moderately difficult tasks. As tasks became more complex and difficult, the difference in results between the different noise levels became less apparent. Though this seems to be counter-intuitive, it could be explained by the fact that the more complex tasks “implicitly encourages children of any age to actively focus their attention on the task in hand” (Caviola et al., 2021, p. 8). The higher levels of concentration involved with more difficult tasks has been shown to negate some of the potential negative impacts of noise on task performance (Caviola et al., 2021).

As I have been discussing in regard to my area of study, we need to rethink our traditional classroom designs to create more inclusive environments. A student or child-centered
approach often calls for more flexible environments with more flexible seating, the use of furniture, options for group seating, and more. The “open-plan” design of schools creates larger, open spaces where multiple class spaces can be combined. These open plan and student-centered styles of classroom come with some concerns, especially related to classroom management and noise levels. Numerous studies from the past 40 years have pointed to intrusive noise from adjacent classes being a significant issue with open-plan classrooms (Shield et al., 2010). Intrusive noise can reduce speech intelligibility and privacy, while causing distraction and dissatisfaction in both teachers and students. In order to successfully implement an open plan classroom, some techniques to limit intrusive or excessive noise are required. These can include things such as absorbent ceilings that are 3.5m high or less, partitions between class groups, limiting the number of class groups sharing the space to three or fewer, and providing sufficient floor space per child (Shield et al., 2010). Such methods can help to ensure that the acoustics of the room don’t become a distraction to those making use of the space and can allow open classrooms to become beneficial, engaging, and flexible learning environments.

Closely tied to the acoustics of a classroom is music. With the widespread availability of cell phones and music streaming services such as Spotify, music in the classroom is a relevant and critical topic for teachers. The connection between music, focus, and cognitive function has been studied for decades. I have spoken with a great number of students who say that they have benefited from the use of music while working at school, but is this a misperception from students who simply want to tune into their own music during class time, or is the positive connection between music and cognitive function based in concrete evidence? There is mixed evidence concerning how music can influence task performance, and numerous studies have shown that music can facilitate, hinder, or have no impact on task performance (Gonzalez &
Aiello, 2019). The mood-arousal hypothesis is based on the idea that listening to music that the user enjoys increases arousal levels and creates a positive mood, which can then lead to increased performance on a cognitive task. The distraction-conflict theory demonstrates that an individual needs to implement relatively few attentional resources to perform well on simple tasks, while, conversely, needs to allocate a large number of attentional resources to perform well with a complex task (Gonzalez & Aiello, 2019). These theories are both relevant when looking at a study carried out by Gonzalez and Aiello (2019), who wanted to determine music’s impact on both simple and complex task performance. Participants in this study worked individually in an office space and were asked to complete a variety of cognitive tasks that varied in complexity. Participants in the group who listened to music listened to a variety of music that could be simple or complex and soft or loud. The control group did not listen to any music. The results of the study showed that generally, music impaired complex task performance, complex music facilitated simple task performance, and that individual preference for external stimuli moderated these effects. This indicates that the connection between music and task performance is complex and will vary between different individuals. “Music does not appear to impair or benefit performance equally for everyone” (Gonzalez & Aiello, 2019, p. 440). These findings would suggest that the best approach to music in the classroom would be to, at times, allow students to individually expose themselves to music through the use of headphones. The use of music should depend on the complexity of the task at hand and the individual’s preference for external stimuli. Goltz and Sadakata (2021) used an online questionnaire to examine how individuals make use of background music while performing various, everyday cognitive tasks. The survey was completed by 140 participants. Consistent with previous evidence regarding music and cognitive performance, the results showed highly diverse strategies between
individuals when it came to the use of music and daily tasks. Despite this, the results did show some general tendencies: People tend to use music less often when engaged in more complex tasks, they become less critical of the type of music they listen to when completing simple tasks, and younger people seem to make use of background music more often than older people (Goltz & Sadakata, 2021). These tendencies seem to be consistent with previous studies, including the previously referenced study from Gonzalez and Aiello (2019). People are listening to music less often when engaged in complex tasks as the music is more likely to impair their performance. They could be less critical of the type of music they are listening to during simple tasks because more complex music can facilitate simple task performance.

**Self-Regulation Spaces**

Self-regulation is not easy to define. It is a well-known concept, especially within the world of education, but the definition can be somewhat ambiguous. Self-regulation involves planning, persistence, and thinking about one’s actions. It is the process of monitoring your own thoughts, feelings, and behaviors (Macklem, 2015). Burman et al. (2015), mentioned a couple of different definitions such as “management of the self, by the self” (p. 1507) and “control over the self, by the self” (p. 1507). Self-regulation spaces are areas created within classrooms or schools that provide a comfortable area for students who are experiencing difficulties with self-regulation to separate themselves from everyone else to calm down. These spaces are designed in a way to minimize sensory input and allow students to regroup. Self-regulation spaces can be created within the classroom or can be located at a separate location in the school.

Scott (2009) argued that “designing low sensory-stimulus environments reduces sensory overload, stress and anxiety” (p. 37). He also rejected the idea that a self-regulation space should be created in a separate room or area of the school. He described such spaces as “a failing in
[themselves]… We wanted the children to have the opportunity to withdraw, but still remain within the social fabric of the school” (p. 38). We can take what is known about designing supportive physical classroom spaces and apply that information to carefully designed self-regulation spaces. By creating self-regulation spaces within the classroom environment, students will have a “mini-oasis” to access in order to calm down, destress, and self-regulate. Scott (2009) demonstrated that rather than being located elsewhere in the school building, self-regulation spaces can be developed in the most inclusive place of all, within the inclusive classroom environment where all students can access it as needed.

Creating a self-regulation space within a classroom isn’t always an easy task. Teachers are working within the classrooms that have been assigned to them and extra space may be hard to come by. According to Martin (2014), this space should be designed as a quiet space that serves as an escape for students. It should provide a withdrawal for students to lessen sensory stimulus and stress. It can be created within a room with moveable screens or walls and a makeshift door (Martin, 2014). According to an article from Learn Magazine (2012), a self-regulation space can be quite easy to create and can be as simple as a blanket or sheet laid over top of two desks with a mat on the floor to sit on (see Figures 7-9). This still creates a refuge for a child that is overstimulated and needs to temporarily separate themselves from the rest of the class. An important consideration with these spaces, however, is that they need to be discussed and modelled with the entire class. More often than not, a student who needs some separation from the class is not going to want to draw more attention to themselves. If the space isn’t understood by the rest of the class or is not commonly used, then the space could have unintended consequences of drawing more attention to the student in need.
Figure 7

A Self-Regulation Space in the Corner of a Classroom

Figure 8

A Self-Regulation Space Sectioned Off With Shelving
It is also a good idea to include some sensory tools and/or activities for students in these self-regulation spaces. According to Sutton et al. (2013), “sensory-based interventions are thought to promote adaptive regulation of arousal and emotion” (p. 500). Sutton et al. (2013) carried out a study in which sensory-based interventions such as massage chairs, rocking chairs, beanbags, weighted blankets, stress balls, weighted soft toys, relaxing visuals and sounds, and adjustable ambient lighting were available to patients within a mental health unit in New Zealand. Results showed that access to these interventions within the sensory room allowed for self-regulation of arousal levels and emotions. When children are feeling upset or frustrated, it is important that they can take care of themselves in a positive way with access to an activity that can relax their minds and reduce their frustration. Such activities can include things like reading, drawing, or Play-Doh (McWhorter, 2018).
Air Quality and Temperature

Factors related to air quality and temperature of the indoor environment certainly play a role in people’s overall health and wellbeing. The scientific evidence is growing that there are also correlations between the indoor environment and cognitive performance in students. Hviid et al. (2020) conducted a field lab study to examine the influence that indoor ventilation and lighting had on children’s academic abilities. The goal of the study was to investigate both the individual and combined effect of ventilation and lighting and the performance of the students. With this goal in mind, the experiment was designed so that the impact of the variables could be gauged individually as well as combined. The study included 92 children who were between 10 and 12 years old and lasted for four weeks in a school in Valby, Denmark. There were four, side-by-side classrooms that were used for the study. These classrooms were well suited for the study, as they all had the same dimensions, window sizes, and orientation towards South-East. Over the course of the 4-week study, students completed a questionnaire and three different performance tests, which measured processing speed, concentration, logical reasoning, and math solving abilities. The experimental design was set up to test the effect of warm and cool lighting at both low (3.9 l/s per person) and high (10.6 l/s) ventilation rates. Over the course of the study, the indoor environment was monitored with wireless IC-Meters which measured CO2-concentration, air temperature, relative humidity, and noise levels. The lighting in the classrooms were based off of colour temperatures of 2900 ± 89 K and 4900 ± 149 K. To evaluate the cognitive processes of the students, three tests were used. The d2-test is a cancellation task that evaluates the visual scanning speed of an individual and measures how well focus can be kept on a task. The Baddeley test was used to measure logical reasoning. It involves the understanding of sentences of various levels of complexity, giving quick feedback on an individual’s ability to
think logically and sensibly. In the math test, students solved multiplication and subtraction questions. A questionnaire was also completed after each Baddeley-test to determine the students’ perceptions of the indoor environment. The results of the study showed that processing speed, concentration, and math skills improved the most in the scenario with high ventilation rates and cool lighting. There was not a significant change in logical reasoning between the various classroom conditions. The results of the questionnaire showed that in general, students were satisfied with the classroom environment, but that the environmental changes made during the study had little impact on their overall perception.

A meta-analysis from Wargocki et al. (2019) detailed published evidence on the impact that temperature in school classrooms has on students’ performance. Data from 18 different studies were used to construct a relationship between classroom temperatures and children’s performance in school. Literature was surveyed to find studies that examined the impact of thermal conditions in the classroom on student performance. The inclusion criteria for articles were that they must have reported both measurements of thermal environment and measurements of the performance of schoolwork or of learning outcomes. Only studies conducted with students younger than 19 years old were used. Psychological tests measuring cognitive abilities, school tasks, tests, and rating schemes were all examples of indicators of student performance. Thermal conditions were simply characterized by measured classroom temperatures. To create the relationship between student performance and temperature, “the fractional change in performance of psychological tests and school tasks was regressed against the average temperature at which the change was recorded; all published data were used regardless of whether the change in learning outcome changed significantly with temperature” (Wargocki et al., 2019, p. 198). The relationship determined from the analysis demonstrated that student
performance of psychological tests and school tasks increased on average by 20% if classroom temperatures were dropped from 30 °C to 20 °C. The analysis also showed that the optimal temperature for performance is lower than 22 °C. The results demonstrated that the impact of classroom temperature on cognitive performance is not negligible and that the impact on students is much higher than it is for adults in office settings. It is worth noting that the relationship between temperature and classroom performance that was constructed is only valid for temperate climates. Temperate climates occur in the mid-latitudes between the tropics and polar regions, where summers are mild to warm, and winters are cool to cold.

In addition to student performance and academic ability, air quality can also impact the health of the occupants of a building. An important process to consider when examining air quality in a building is ventilation. Ventilation is the process of exchanging the air inside a building with air from outside of the building. For this to be effective, the air being brought in from outside should be clean. The purpose of ventilation is to “create optimal conditions for the occupants of indoor environments, taking into account their health, comfort, and cognitive and physical performance, by providing air for breathing while removing and/or diluting any contaminants that are present indoors” (Carrer et al., 2015, p. 274). Ventilation can also be used to control the temperature and humidity of the indoor environment. Because of this, ventilation plays a significant role regarding the indoor air quality of a building. Indoor air quality (IAQ) has been a topic of interest since the World Health Organization (WHO) declaration of “Sick-Building Syndrome” in 1986. Low IAQ can affect comfort, health, task performance, and perceived IAQ (Wolkoff et al., 2021). A literature review from Woloff et al. (2021) summarized some useful information related to air quality. They found that cognitive and office work performance was optimal between 22 °C and 24 °C in regions with temperate climates. This is
consistent with the findings of Wargocki et al. (2019), who stated that the optimum temperature for students (below 22°C) is lower than that of the optimum temperature for office work. Low indoor air humidity can cause an elevation in mucous membrane-related symptoms such as dry and tired eyes. This is due to less efficient mucociliary clearance caused by the low indoor air humidity. “Relative humidity between 40 and 60% appears optimal for health, work performance, and lower risk of infection” (Wolff et al., 2021, p.1). Proper ventilation can reduce both acute and chronic health outcomes, while also improving work performance, which is due to reduced exposure to indoor air pollutants. Carrer et al. (2015) reviewed scientific literature to determine the connection between building ventilation and health (disease) outcomes. This review determined that, in general, higher ventilation rates will often reduce negative health outcomes. However, they were not able to determine an air ventilation rate that could be universally applicable within different buildings, as the literature showed a range of ventilation rates that provided positive benefits. The lowest ventilation rates at which there were no effects on health outcomes were 7 L/s per person, while the highest were 40 L/s per person. Though this is a wide range, they were able to determine that overall, an increase in ventilation rates had positive results. Higher ventilation rates were beneficial to those with asthma and allergies. Increased ventilation rates can also reduce the onset of acute health symptoms. An example of this is a reduction in mucosal symptoms, which includes dry eyes, sore throat, sore nose/sinus, and sneezing. They also found that there is a strong association between ventilation rates and absence rates of students in schools. A 1000 ppm increase in CO2 above outdoor levels due to a lower ventilation rate was associated with a 10-20% increase in student absence. Increasing the ventilation rate from 12 to 24 L/s per person was associated with a reduction in short term sick leave among office workers (Carrer et al., 2015).
British Columbia’s education system promotes an inclusive model of education that aims to make the classroom engaging and accessible to all students. As is quite evident from the literature, the physical environment is crucial in creating inclusive and engaging classroom experiences for students with varying needs. “Classrooms constitute school-aged children’s most important learning environments. It is important to understand the characteristics of this learning environment to be able to make informed changes to improve the conditions for optimal learning” (Brännström, 2021, p. 2). The physical classroom environment is made up of a number of elements, including, but not limited to, dynamic seating options, classroom arrangement, lighting, wall colour, artifacts and decorations, noise and acoustics, air quality and temperature, and incorporation of self-regulation spaces. All of these elements play an important part in the development of effective classroom environments that promote inclusion and engagement. As educators strive to create more inclusive schools, we cannot overlook the importance of the classroom environment, which according to Ackah-Jnr and Danso (2018), is “a critical implementation factor influencing inclusive education” (p. 189). The physical classroom environment will be an essential building block as we continue to create more inclusive classrooms across British Columbia.
Chapter Three: Considerations for the Design of the Website

This Applied Project is a compilation of research related to the physical environment of the classroom. More specifically, it focuses on how the physical environment of the classroom impacts engagement and inclusion. The research I have compiled has been translated into guiding ideas and recommendations on a professional website that will support educators in creating more inclusive and engaging learning environments. The physical classroom environment is something that has developed into a great interest of mine, and I believe it is very important that we start putting more energy into the purposeful design of our classrooms. It is my hope that through the creation of this project, I will make evidence-based practices readily available to educators, administrators, policymakers, and school planners in an easy to access format. This chapter will provide insight into my design process, an overview of the website I have designed, justification for my choice of platform, and reflections on challenges I encountered along the way.

Overview of the Website

When planning out the design of my website, the first thoughts that came to my mind were simplicity and ease of access. In today’s online world, we are overwhelmed with content coming at us from every direction. Smartphones have made an unfathomable amount of information instantaneously available to us at any time. Because of this, we have become much quicker to filter through content if we don’t quickly find what we need. News, entertainment, how-to videos, educational content, and much more are routinely condensed into bite-sized videos or infographics. The world of education has not been an exception to this trend of quick and easy to digest content. One can now scroll through TikTok, Instagram, or Pinterest and discover an abundance of teacher tips and tricks; useful information condensed into quick, easy
to understand videos and photos. This is what led to my emphasis on simplicity in the creation of my website. I want users of the website to be able to find what they are looking for quickly and easily. The information is provided in short, easy-to-understand ideas and recommendations that are free of educational jargon. According to Hirschkorn and Geelan (2008), teachers “often have little patience for theory and discussions that challenge them to rethink their practice in fundamental ways, and do request ‘practical’ and directly applicable results from research” (p. 6). Of course, if users are interested in reading more into the research behind these evidence-based practices, I have provided summaries and citations of all the studies that are supporting my recommendations. My website has been organized into a few separate pages. The home page introduces the topic and provides an overview of what the website will provide. Using the navigation bar at the top of the website, the user can navigate to their choice of four different pages: Inclusion and Engagement, The Key Elements of the Physical Classroom, Resources, and References. The Inclusion and Engagement page introduces these terms and how they apply to the physical classroom environment. A few YouTube videos have been embedded to provide further explanation of these terms. The Key Elements of the Physical Classroom page is where users can find all the recommendations and evidence-based practices. I have divided this section into subcategories based on different elements of the classroom. A Resources page has been included to connect the user with several different resources that may be helpful for them to incorporate some of the recommendations found on the website into their own classroom. This includes things such as links to useful products, informative YouTube videos, and educational websites. The References page will include a list of all the sources I cited in my project.

The process of building the website was not easy for me. I am relatively inexperienced with web-design and have never had an eye for artistic projects. The first step for me was to pick
a website building platform. I knew of a few free website builders online and had some experience with Weebly. However, after conducting some research, I felt that paying for a subscription-based website builder would provide me with more design flexibility, a more professional-looking website that was free of advertisements, and a simple domain name that did not need to incorporate the name of the website builder I was using. I ultimately made my decision when I discovered that Squarespace offers a significant discount to university students. In addition to this, Squarespace is also a great web-design platform. They offer professional looking templates, great design flexibility, a user-friendly interface, online webinars, a help center, and discussion forums where you can discuss ideas with other Squarespace users. These features were crucial in my learning process as I figured out how to put my website together and present my information in the way I had envisioned. Through one of Squarespace’s webinars, I was also able to learn the basics of Search Engine Optimization (SEO), which can allow me to make my website easier to find. SEO is a process of making a website easier to find and access, which inevitably increases traffic to the website. There were no templates that offered exactly what I was looking for, but I was able to choose one that met my basic requirements, and I learned to add/remove features as I built the website. After all the hours spent learning, designing, and making revision, I believe I have created a website that looks great and stays true to the original guiding principles I came up with at the start of this process: simplicity and ease of access.

**Justification for Creation of a Web-Based Resource**

Advancing inclusion within the educational system in British Columbia is essential as we continue trying to better meet the needs of all students. Teachers and the practices they incorporate into their classrooms will be the driving force behind making positive changes in
relation to inclusion. As previously stated, “the beliefs and attitudes of teachers are a powerful force that either promotes and advances or impedes and obstructs reform” (Mazurek & Winter, 2015, p. 649). Teacher attitudes and self-efficacy are improved through effective professional development and resources that provide teachers with concrete examples of evidence-based practices they can use within their classrooms. Unfortunately, research has shown that few teachers are making use of researched-based practices in their classrooms (Martin, 2016; Neill & Etheridge, 2008). This issue is what is known as the research to practice gap. “At least in part, this gap is due to the fact that much relevant research is not available to educators in a readily accessible form” (Mitchell, 2006, p. 1). My website makes research and evidence-based practices related to the physical classroom environment readily available to teachers across the world. Wide-spread availability and ease of access are two of the main reasons I elected to create a web-based resource for my project. Teaching is a demanding profession, and teachers are kept busy with marking, prep, parent communication, and much more. For a lot of teachers, these responsibilities often take place outside of the hours of the regular school day. A web-based resource allows teachers to access information at their own convenience. This is important, as “quality professional development must meet the demands and needs of the person engaging in the activity. However, many opportunities for special educators are often less than optimal in terms of timeliness, expertise, or applicability” (Cook et al., 2017, p. 109). Online resources are important for teachers who “experience geographical isolation from other colleagues and would benefit from using online resources to share ideas and obtain answers to challenges they may be experiencing in their teaching” (Cook et al., 2017, p. 110). By taking advantage of mass media and interpersonal channels of communication, web-based platforms are powerful tools for disseminating research. They can improve awareness about,
and subsequent adoption of, evidence-based practices (Lord et al., 2019). A survey of 2,462 teachers was completed to determine how digital technology has helped them in teaching their high school and middle school students (Purcell et al., 2020). Nearly all the respondents (99%) reported using the internet to conduct research for their job. Ninety-two percent of the teachers surveyed said that the internet has a “major impact” on their ability to access content and resources to help them with teaching, while 69% said the internet has a “major impact” on their ability to share ideas with other teachers. Eighty-four percent of the teachers involved use the internet at least weekly to find content that will engage their students and 80% use it to help them develop lesson plans. Another important finding from the survey was that 93% of the teachers own a laptop versus about 61% of the general adult population (Purcell et al., 2020). Based on these numbers, the internet is clearly a widely relied upon means for teachers to conduct research, and therefore, an effective medium for an educational resource with the goal of disseminating evidence-based practices.

Another benefit of using websites for educational resources is that they can easily be updated and changed. Websites are dynamic resources that can be revised as new information becomes available. These changes can be made without interrupting access to users. This is important, as it means that the website can stay relevant, reliable, and current as researchers continue to learn and publish more content related to the physical environment of classrooms. Websites also allow content to be presented in a variety of ways. My website includes information in the form of text, graphics, and videos. This allows users with different learning preferences to access information that will be engaging for them.

Teachers aren’t going to make use of any website that they stumble across on the internet. With so much information available online, there are factors that need to be
considered when designing a website so that educators will find it useful and engage with its content. A study from Beach and Willows (2014) aimed to understand the factors that motivate teachers to use internet-based resources. Seven pre-service student teachers and four in-service teachers took part in the study, and were asked to explore a free, interactive, and evidence-informed professional development website. As the participants navigated through the website, a screen recording software was used to capture their exploration patterns. After they explored the website, the participants revisited the choices that they made and were given a chance to verbalize their thoughts as they observed their own screen recording. The results helped researchers to determine some of the factors that motivate teachers to make use of professional development websites. These factors included quality of information, ease of use, appearance, and usefulness of information. Quality of information refers to the trustworthiness of the website and that the information is supported by credible research. Content on an educational website “should not only be relevant, but it should also come from reliable and cited sources” (Beach & Willows, 2014, p. 11). Ease of use was mentioned by most participants, as they said it was important to them that they could easily navigate the website and find the information they were looking for. Other important factors related to ease of use were highlighting the purpose of the website on the homepage, having information in a logical order, and having the website easily accessible through search engines. The appearance and visual design of a website will have a significant impact on whether a user returns to and/or uses a website. Appearance includes characteristics such as space provision, choice of colour, and font selection. Media such as graphics, photographs, and videos were also important to the participants. Lastly, the findings from the study suggested that the usefulness of information was a very important factor for website users. While navigating
through the website, all the participants considered how the resource would contribute to their knowledge of teaching and implementing lessons in their classrooms. They noted that by gaining knowledge in content areas that apply to their own practice, they have an opportunity to improve their teaching practices and therefore, the educational experience of their students (Beach & Willows, 2014). The results from this study provided valuable insight into the design of my own professional development website.

**Challenges**

The design of this educational resource came with some significant challenges along the way. Once I decided on using Squarespace to build my website, I struggled to start the process, as I couldn’t find a template that was exactly what I was looking for. I quickly realized I would need to choose a template that was similar to what I was envisioning and make my own changes. Luckily, Squarespace is quite intuitive when it comes to things like adding or moving text, including photos, and creating headings. Where I ran into difficulty is when I wanted to create more specific features for my website. A good example of this is the feature I included where users can click on a recommendation and have a summary of the supporting studies appear. I also found using text or images to link to other pages difficult.

One of the more challenging aspects of designing the website was figuring out how I was going to present the pages and pages of research I had compiled to the users of my website. I decided to condense the findings of my research into concise, jargon-free recommendations and summaries. This process was time-consuming, and I hadn’t accounted for how much time this would take in my planning. I wanted my recommendations to be simple and easy to find, but I also wanted users to be able to access summaries of the studies that supported these recommendations. This is when I came up with my idea to add an option for users to be able
to click on the recommendation to access a summary of the study or studies that supported it. This feature allowed users who weren’t as interested in the supporting research to quickly browse the website for ideas without being inundated with mass amounts of text related to studies, while also giving users who wanted to read a summary of supporting studies the option to do so.

The process of compiling my research, designing a platform to host it on, and translating it into user-friendly recommendations has been a long and rewarding one. I’ve learned skills that will surely help to improve my practice as an educator. The process of building a website with a program I have never used before challenged me more than I expected it to. Overall, I believe I have created a website that will provide useful information and recommendations to educators who wish to make their classrooms more inclusive and engaging.
Chapter Four: Reflection and Conclusions

My Journey

When I graduated from UVIC with a Bachelor’s of Education in 2015, I left school with the intention of teaching Physical Education and Social Studies for the remainder of my career. After a successful and rewarding practicum experience, I was certain that I had found my dream career. After several contracts teaching a combination of PE, Social Studies, English, and Career Education, I started a job that had me teaching a course called Citizenship. The goal of the course was to try and connect with some of the vulnerable students at our school who were struggling academically, socially, or behaviorally. We wanted to try to get them more involved in their school and community. I led the class through all sorts of activities based around study skills, organizational skills, mindfulness, empathy, and community/school awareness. I felt that I made a solid connection with these students, and I realized that this was what they really needed. They needed someone they could have a positive connection and relationship with. They needed to feel like school was a safe place where they were valued and understood. After this contract ended, I was lucky enough to get hired to run the behavior / learning support program at our school when the previous teacher retired at the end of the year. I started this position in September 2020 and have loved every minute of it. It was definitely a steep learning curve as I navigated my way through Individual Education Plans (IEPs), designation requests, case managing, individualizing student programs, and more. I have now been running this same behavior and learning support program for the past two years, and it is what inspired me to pursue my Master’s in Special Education.

As I began my graduate studies journey, I developed an interest in the physical environments of classrooms. This interest developed through experiences in my own classroom,
conversations with teachers and students, and from a presentation during one of my classes at VIU. I have had numerous conversations with students at school where they have talked about being uncomfortable in class and having difficulty focusing on their work. Though this likely stems from a variety of factors, I believe that the classroom environment plays a large role in the attention, engagement, and mood of students at school. Students have outlined to me their difficulties with uncomfortable chairs, not being able to sit with and interact with peers, lighting that gives them a headache, and more. This really got me thinking about the environment that I had created for the students in my program. The students I work with have a diverse range of needs, and I wondered if the environment I had created in my classroom would set them up for success. My initial reaction when looking around my room was that it wouldn’t. The chairs were uncomfortable, the lighting wearisome, and the walls were bland. I began thinking about ways that I could make the physical environment of my room more inspiring and conducive to student engagement. I started searching Craigslist and Facebook Marketplace for computer chairs. I was lucky enough to find a few that were cheap but also in good condition. These chairs were softer and more comfortable, but they also allowed students to rock back and forth and adjust the height at which they were seated. I was also able to find a couple of leather recliners. I made some space on the perimeter of my classroom for the recliners so that students had a spot they could kick their feet up and relax while reading a book. I started to make the walls less bland by putting up photographs and examples of student work. These small changes received positive reviews from my students, though it still seemed like there was a lot more that I could do to improve the room. My suspicion was confirmed when I saw an example of a classroom in Alberta during a MEDS 510 presentation. This teacher had included plants all around the room, included alternate forms of seating, and had even put tennis balls over the bottom of the legs of
chairs so that they weren’t as noisy and distracting when they were pulled out and moved. They also included a quiet, self-regulation space in one of the corners of the room.

As we began researching topics of interest for MEDS 510 and 530, I began learning more and more about the physical classroom environment. My findings were interesting and relevant to my practice, and they sparked my desire to continue making alterations to my classroom space. I made sure to include tables where students could sit together, more alternate types of seating in the form of wobble stools, study carrels where students could feel like they had a little more privacy, a quiet self-regulation space, and indoor plants spaced around the room. I’ve found that making these changes has been essential for providing a welcoming environment in my room. Right now, reports of anxiety and depression in school-aged students are at an all-time high (Causton & MacLeod, 2020). Often, my classroom serves as a safe space for students who experience anxiety at school. Because of the number of vulnerable students in my classroom, I believe it is crucial that I create a place where students feel they belong and where their basic deficiency needs are met. These needs include physiological needs, safety, love, and esteem. Students whose most basic needs aren’t being met will have very little, if any, energy to put towards learning (Brownlie & King, 2012).

As I began planning for my Thesis / Applied Project, I struggled to figure out what I wanted to create. I knew I wanted my research to be based around the physical classroom environment, but I didn’t know what form I wanted this to take. Initially, I planned to conduct a needs assessment related to the physical classroom environment and investigate what evidence-based practices were being incorporated into classrooms in BC. After spending some time planning and thinking this through, I decided that I wanted to shift my focus from my own independent research (in the form of a needs assessment) to the creation of a learning resource.
Though only anecdotal evidence, it seemed to me that the majority of secondary classrooms that I visited were not making use of many evidence-based practices related to the physical environment of the classroom. I decided that I would rather put more time into a professional development resource that could educate teachers about the classroom environment, rather than a needs assessment to determine the significance of the research-to-practice gap in this area of study. This was how I felt I could best make use of my time and spread awareness of the importance of the classroom environment.

Summary of Findings

My applied project involved an in-depth investigation into the physical environment of the classroom. My research has been guided by one central question that covers a broad array of literature: What do teachers need to know about how the physical classroom environment impacts student engagement and inclusivity? Such a question leads down many different paths, and my research spanned a number of different topics. These topics included alternative seating options, lighting, the use of flexible learning spaces, plants, acoustics, music, wall colour, seating arrangements, air quality and temperature, and the use of self-regulation spaces. Through my review of the literature, I discovered that all of these topics have some sort of impact on inclusion or student engagement. In my personal experience, many teachers are not optimizing their classroom environments to be as engaging and inclusive as possible. See Appendix A for a summary of my main findings.

Discussion

The research I have compiled has certainly impacted and expanded my practice as an educator. I feel that my classroom environment has become more inclusive as I’ve engaged in the learning process throughout my work on this project. This project has been satisfying to work
on, as it feels good to expand my knowledge in a subject that is directly benefiting my practice as a teacher. Since beginning my project, I’ve started including more types of seating in my classroom, included plants as decorations, created a self-regulation space in my office, and been more mindful of my seating arrangements. I still have a lot to improve in my classroom environment, but I have certainly made some positive progress. Since I started teaching, I have firmly held on to the belief that developing positive relationships with students is one of most important things that teachers can do. This project has only further cemented my belief, as much of the literature points to individual differences and preferences of students. If you know a student well, you will recognize when they need a break in a self-regulation space; you will know whether or not their music is actually helping them focus with certain tasks; you can identify when an alternate form of seating is beneficial or just a distraction. Even before I put together my website, I found that with colleagues asking me about my topic of research, I was having a lot of conversations about the physical environment of classrooms, and it seemed like more people started thinking about their own classrooms and changes that they could make. Ultimately, my goal is to spread awareness about the impact our classroom environments can have on students. I think that my website will help to accomplish this goal. The process of creating my website has been very rewarding, and I think I have put together a resource that will be beneficial and easy to use for educators.

**Limitations**

Though I believe my website is a valuable resource for educators, I certainly recognize that it comes with limitations. Though websites can be easy to access, they aren’t always easy to find. I can promote my website and share the address with colleagues, but my reach is fairly limited in that regard. To increase traffic, websites need to be easily accessible through search
engines. I was able to learn the basics of SEO through Squarespace, but it seems I would need more technical skills and finances to make my website easier to locate through search engines. An example of this would be paying for Google Ads, which is a quick way to get your webpage to the top of the search results and increase your online exposure. I will already be paying Squarespace to host my webpage, and more monetary investment is not realistic for me at this point. Regular maintenance is also a limitation with websites. I need to keep my website functioning smoothly, which means making sure links are still working, updating the copyright year on the page, and more. I also need to make sure that the information and evidence-based practice I am including on my website is current. Our understanding of the physical classroom environment will continue to evolve as more research is conducted, and I want to make sure the information I am providing is up to date. This will mean keeping up with the latest literature and modifying the recommendations on my website accordingly.

In terms of limitations within my research, I think I could have explored more in relation to the impact of buildings and architecture on humans in general, outside of the world of education. There was certainly more research in this area, and though it is not specific to education, I think there is a lot of information that still would have applied to schools and the field of education. With the time it took me to read through studies and articles, I found that I did not have the time to stray from the more education-specific studies that more directly applied to my topic. This is certainly an area that I would like to investigate more in the future.

I think that right now, many students are uninspired, or even hindered, by the physical environments of their classrooms. This impact is magnified for many students with learning difficulties, which is why I believe this topic is so important. As we continue to create more inclusive learning spaces in British Columbia, I am excited to be a part of this change. I look
forward to passing on my newfound knowledge to others on how to create environments that are more conducive to inclusion, learning, and overall engagement. I hope that my research and website can, at the very least, be a small part of a large shift in education and perspective on how we view our classroom environments. There are evidence-based practices that can be incorporated into classrooms across BC that will make a significant difference for students with all sorts of different learning needs. I believe that we can make our schools a place where students feel more comfortable and welcome. Our classrooms can be spaces that inspire, rather than inhibit.
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## Appendix A

Summary of Key Learnings Related to the Physical Classroom Environment

<table>
<thead>
<tr>
<th>Element of Classroom</th>
<th>Key Learnings</th>
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</table>
| **Alternate Seating** | • Various sized desks/chairs should be made available to students  
• In-seat and attending behavior can be improved for students with Down Syndrome (DS) and Autism Spectrum Disorder (ASD) with the use of dynamic seating (Krombach & Miltenberger, 2019; Macklem, 2015; Revneke & Hoosain, 2020).  
• Students with Attention Deficit Hyperactivity Disorder’s (ADHD) on-task and in-seat behavior can be improved with the incorporation of dynamic seating (Ghanizadeh, 2011; Gochenour & Poskey, 2017).  
• Make sure to model proper use of dynamic seating (Gochenour & Poskey, 2017; Krombach & Miltenberger, 2019; Macklem, 2015; Revneke & Hoosain, 2020). |
| **Seating Arrangement** | • Students with attention difficulties should be seated closer to the teacher (Blume et al., 2019).  
• Social acceptance and prosocial behavior can be promoted in students with externalizing problems by seating them next to well-liked and prosocial peers (van den Berg & Stoltz, 2018).  
• Cluster seating (similar to group/table seating) is most effective for collaborative learning (Simmons et al., 2015).  
• Horseshoe seating can make lessons more engaging and encourage participation in discussions (Simmons et al., 2015; Yang et al., 2021).  
• A seating arrangement in traditional rows leads to fewer off-task behaviors (Simmons et al., 2015).  
• Make use of various seating arrangements (Salend, 2015; Simmons et al., 2015).  
• Involve students in decision making related to seating arrangement (Salend, 2015; Simmons et al., 2015). |
| **Lighting** | • Natural light can be beneficial to students (Gou et al., 2013; Porras Álvarez, 2020).  
• Classrooms are often over-lit with fluorescent lights (Winterbottom & Wilkins, 2009).  
• It is beneficial if classroom light (both natural and manmade) can be effectively controlled (Winterbottom & Wilkins, 2009). |
### PHYSICAL CLASSROOM ENVIRONMENT

| Flexible Learning Spaces | • Flexible learning spaces facilitate self-regulation, collaboration, student autonomy, and engagement (Kariippanon et al., 2018).
|                          | • Flexible learning spaces are seen as more enjoyable, comfortable, and inclusive, by students (Kariippanon et al., 2018).
|                          | • Students in flexible learning spaces spend less time verbally off-task, being engaged in teacher-led instruction, working independently, and negatively interacting with others (Kariippanon et al., 2019).
|                          | • Students in flexible learning spaces spend more time collaborating, working in groups of more than six students, actively engaging with the lesson content, and positively interacting with others (Kariippanon et al., 2019).
|                          | • Flexible learning spaces can encourage student-centered pedagogical approaches (Kariippanon et al., 2018; Mulcahy et al. (2015)).
| Wall Colour              | • Colour contrast should be created for critical surfaces in the classroom, though the contrast should not be too drastic (CPD 6, 2018).
|                          | • Colder hues can improve student memory and attentiveness (Linares et al., 2021).
|                          | • Colder coloured walls are perceived more positively by students (Yildirim et al., 2014).
|                          | • Colour choice can affect student concentration and stress levels (Pourbagher et al., 2021).
| Plants                  | • Views of nature, live plants, and the use of the colour green can all led to increased creativity in students (Studente et al., 2016).
|                          | • Indoor plants in a classroom can increase student happiness (Najafi & Keshmiri, 2018).
|                          | • Indoor plants can improve air quality through reduced air pollution, which as a result, improves indoor environmental quality (IEQ) (Jamaludin et al., 2017).
Physiological Classroom Environment

- Indoor plants can lower concentrations of airborne contaminants and create more constant air temperatures, relative humidity, and CO2 levels (Jamaludin et al., 2017; Kim et al., 2020).
- Indoor plants can lead to increased attention capacity in students (Kim et al., 2020).

Acoustics and Music

- Noise levels can negatively impact learning attainment, cognitive processing, reading, and to a lesser extent, numeracy tasks (Shield et al., 2010).
- Children’s speech perception is more significantly impaired than adults’ by unfavorable listening conditions (Klatte et al., 2013).
- Students require an environment with favorable listening conditions to effectively decode and process oral information (Klatte et al., 2013).
- Non-auditory tasks such as short-term memory, reading and writing are impaired by noise (Klatte et al., 2013).
- There is evidence that points to sound levels having a chronic impact on children’s cognitive development (Klatte et al., 2013).
- Noise levels impact younger children more than older children (Caviola et al., 2021; Klatte et al., 2013).
- Higher noise levels have the most detrimental effect with moderately difficult tasks when compared to more difficult and complex tasks (Caviola et al., 2021).
- Noise levels can become an issue with “open plan” classrooms, where there can be multiple classes within a large space. Open plan classrooms should make use of absorbent ceilings that are 3.5m high or less, partitions between classes, limit the number of classbases to three or fewer, and provide sufficient floor space per child (Shield et al., 2010).
- There is mixed evidence concerning how music can influence task performance, and numerous studies have shown that music can facilitate, hinder, or have no impact on task performance (Gonzalez & Aiello, 2019).
- The mood-arousal hypothesis is based on the idea that listening to music that the user enjoys increases arousal levels and creates a positive mood, which can then lead to increased performance on a cognitive task (Gonzalez & Aiello, 2019).
- The distraction-conflict theory demonstrates that an individual needs to implement relatively few attentional resources to perform well on simple tasks, while, conversely, needs to allocate a large amount of attentional resources to perform well with a complex task (Gonzalez & Aiello, 2019).
- Music impairs complex task performance and complex music facilitates simple task performance, but individual preference for external stimuli moderates these effects. This indicates that the
The connection between music and task performance is complex and will vary between different individuals (Gonzalez & Aiello, 2019).

- “Music does not appear to impair or benefit performance equally for everyone” (Gonzalez & Aiello, 2019, p. 440).
- Younger people make use of background music more often than older people (Goltz & Sadakata, 2021).

<table>
<thead>
<tr>
<th>Self-Regulation Spaces</th>
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<tr>
<td>Incorporating self-regulation spaces into classrooms can help students reduce stress, anxiety, and sensory overload (Scott, 2009).</td>
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<tr>
<td>When possible, self-regulation spaces should not be created in separate rooms or areas in the school. Students should have the opportunity to withdraw in a self-regulation space without leaving the social fabric of the school (Scott, 2009).</td>
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<tr>
<td>Self-regulation spaces can be created within a room with moveable screens, walls, or bookshelves, with sheets or blankets laid over desks and mats on the floor, or with other structures like tents that create separation between the rest of the classroom (Martin, 2014).</td>
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<tr>
<td>Self-regulation spaces should be discussed and modelled with the entire class to reduce stigma around students using them (Martin, 2014).</td>
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<td>Include some sensory tools and/or activities for students in self-regulation spaces. These can include massage chairs, rocking chairs, beanbags, weighted blankets, stress balls, weighted soft toys, relaxing visuals and sounds, and adjustable ambient lighting. These tools allow for self-regulation of arousal levels and emotions (Sutton et al., 2013).</td>
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<th>Air Quality and Temperature</th>
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<td>Processing speed, concentration, and math skills improve in classrooms with high ventilation rates (Hviid et al., 2020).</td>
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<tr>
<td>Student performance of psychological tests and school tasks increases on average by 20% if classroom temperatures drop from 30 °C to 20 °C (Wargocki et al., 2019).</td>
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<tr>
<td>The optimal temperature for performance in the classroom is lower than 22 °C (Wargocki et al., 2019).</td>
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<tr>
<td>The impact of classroom temperature on cognitive performance in students is much higher than it is for adults in office settings (Wargocki et al., 2019).</td>
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<tr>
<td>Low indoor air humidity can cause an elevation in mucous membrane-related symptoms such as dry and tired eyes (Wolfoff et al., 2021).</td>
</tr>
<tr>
<td>“Relative humidity between 40 and 60% appears optimal for health, work performance, and lower risk of infection” (Wolfoff et al., 2021, p.1).</td>
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• Proper ventilation can reduce both acute and chronic health outcomes, while also improving work performance, which is due to reduced exposure to indoor air pollutants (Wolff et al., 2021).

• In general, higher ventilation rates will often reduce negative health outcomes (Carrer et al., 2015).

• There does not seem to be a universally applicable ventilation rate between different buildings that is beneficial. The lowest ventilation rates at which there were no effects on health outcomes were 7 L/s per person, while the highest were 40 L/s per person (Carrer et al., 2015).

• There is a strong association between ventilation rates and absence rates of students in schools. A 1000 ppm increase in CO2 above outdoor levels due to a lower ventilation rate was associated with a 10-20% increase in student absence (Carrer et al., 2015).

• Increasing the ventilation rate from 12 to 24 L/s per person was associated with a reduction in short term sick leave among office workers (Carrer et al., 2015).