

**“DON’T GIVE ME THAT RED LEGO TABLE!”**

**HOW THE PHYSICAL CLASSROOM ENVIRONMENT IMPACTS STUDENT LEARNING  
AND TEACHER EFFICACY**

By

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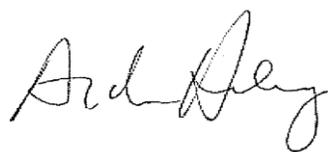
**“Don’t Give Me that Red Lego Table!”**

How the Physical Classroom Environment Impacts Student Learning and Teacher Efficacy

APPROVED:

A handwritten signature in black ink that reads "Charles Scott". The signature is written in a cursive style with a long horizontal stroke at the end.

(Faculty Advisor)

A handwritten signature in black ink that reads "Ardley". The signature is written in a cursive style with a long horizontal stroke at the end.

Principal of Canadian Programs)

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## **Abstract**

This paper was initiated in order to discover how deeply a classroom's physical design could impact a student's learning and a teacher's efficacy. Research is analyzed for evidence of the cumulative effects of lighting, colour, and space as well as noise, smell, and temperature within an educational setting. The results of this literature review indicate that an ideal classroom should be large enough to offer a minimum of 50 ft<sup>2</sup> per child, provide unhindered pathways, have controllable and ample lighting preferably with natural light, use neutral colours such as grey or beige, and provide varied and flexible seating arrangements for individual or group study. The preferred classroom environment should also seek to neutralize smells and deaden background noises (ex. furnaces, roads, other classrooms). The overall conclusion from this literature review is that the teacher can not only positively influence both his/her students' learning outcomes, but also substantially increase his/her sense of ownership and career satisfaction by creating a classroom design guided by research.

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## Don't Give Me That Red Lego Table!

### How the Physical Classroom Environment Impacts Student Learning

#### Chapter One

##### Background Story

It was a tough class. In fact, the previous teacher who had taught grade four at our school for the last fifteen years had posted out because she did not want to teach this cohort. That worried me. Two of the students were runners, meaning they would leave the room often at a quick trot without any warning. One even raced down the hall, slinging his clothes off with every step, out the front doors, across the parking lot, and onto the road, before the principal finally caught up with him. The other boy was large for his age and was very close to trouncing me in the height department. However, his level of understanding approximated a toddler and his behaviour would escalate much like a toddler's would. My class was packed with thirty-one students. Seven had learning disabilities although none were designated. No Educational Assistant was assigned to the room for the first four months.



**Figure1: The bright cheery yellow bulletin boards with black trim, art displayed from the ceiling, and individual row desk seating.**

That year, I had come into the classroom intent on creating a warm and delightful working space. I spent hours in the summer putting up uniform black bulletin board paper with yellow lettering and on the opposite walls yellow paper with black lettering. I had purchased bright and colourful number lines and fraction displays from the teacher's store and placed them in the traditional

space high above the chalkboard. By September, it was ready. As the year progressed, I displayed the students' work liberally throughout the room and even hung it from the ceiling. Everyone who came in mentioned how cheery the room appeared. I had placed the two "runners" at opposite ends of the room and was forced to use a U-shaped table as a desk for the bigger boy as a pseudo playpen to contain him from wandering. He sat at the "teacher's spot inside the U and then I pushed the table against the wall. He liked it and he would complete some work there, but not for long. Everyone else had a desk placed singly into five long columns down the classroom.

After one particularly chaotic day, our district counselor walked by and stopped to chat about a couple of my students. During this talk he casually asked if I had ever considered making my classroom "less stimulating". He went on to say that many of these highly agitated students work best in bare rooms with little visual distraction. I could see what he meant, but just couldn't see my way clear to tear down my hours of beautiful decorations.

However, the following summer, his words echoed in my head. Calm, serene, beautiful.



Figure 2: My new blue/brown colour scheme complete with table groupings and curtains.

Could I bring in some of those qualities to my room? Why not? I put curtains on my windows, chose only two "nature-inspired" colours (turquoise blue and chestnut brown), removed all desks and replaced them with tables, bought four lamps, and refrained from all ceiling decoration. My class that year had several students who needed a calm work environment, yet as a whole our year

together was peaceful and filled with cooperative learning. Was I onto something? Would this simple change of environment create such a difference in the behaviour of my students? I had to keep trying.

Fast-forward two years to September of 2013. I was coming back into my classroom after having suffered a terrible car accident only a couple months before. I had sustained a concussion or in the medical world, a moderate traumatic brain injury. I had difficulty walking fast; I relied heavily on notes to aid my now faulty memory, and had the very trying handicap of finding speech hard to process quickly. To further complicate matters, my speech would often come out incorrectly. I would intend to say a child's name and instead say "pencil" as that was the last thing I had seen before speaking. It was very difficult, but I could still teach. I had to make adaptations so that I remained competent and didn't wilt under the pressure of twenty-four little children fighting for my attention. Bright fluorescent lighting gave me severe headaches, as did any background "din". I even took naps during recess and pulled to the side of the road after fifteen minutes of driving so that I could nap before being able to complete my half hour commute home. Many times that year I found myself seeking quiet, calm spaces filled with natural light.

That was how I discovered that I needed bare spaces. I neutralized the colours in my room to beige walls, brown tables, and a black countertop. I concealed cluttered spaces like toy shelves with neutral coloured fabrics and put all displays of children's work on our hallway bulletin boards instead of within our small classroom. We used lamps and natural light from the windows to personalize spaces in the classroom. I painted the green chalkboards white and used them as a magnet wall. There were no mass produced number lines or alphabet strips. There were no desks. We used laptop tables, pillows, and low end tables. I did not have a teacher's desk: I came to

them. I only used black lettering against white when writing or printing and all artwork was displayed with the same black background paper. The children loved it. They could be responsible for how they wanted their space to be. They could change the lighting to suit their needs. They could sit at a table or on the floor. They also learned to respect that each student chose differently and they were respectful of each other's choices. The year went by fast and I continued to recover.

The next year, we brought nature back into our classroom from our walks outside. We



Figure 3: Our final configuration in June 2015. Next year the U-table will disappear leaving more space for students.



Figure 4: Our class during Daily 5 Independent Reading



Figure 5: Our student designed and created number line

displayed student's family pictures; we experimented with table arrangements, and removed even more furniture from the room. We had space to breathe. We owned the space.

As we were preparing for the end of the year, teachers were sorting through their inventories preparing for the next year. One teacher approached me with a great find that she could no longer use in her room. It was a red Lego table. Red was not a colour now found in my room. It would stand out and become an inadvertent focal point. I truly felt that despite its great functionality in a grade one classroom, we just couldn't accommodate such a jarring visual distraction. Hence the title of this paper, "Don't give me that red Lego table".

Parents had mixed reactions to my classroom modifications over the years. Usually the response was positive. The classroom had a calm atmosphere. It was "comfy and peaceful". The word "relaxed" was used a lot. However, to quote one particularly unconvinced parent, "What exactly was my educational reasoning behind not using traditional desks?" Some parents thought that because the classroom was not in a traditional style, that the learning would be "airy fairy" and that their children would fall behind academically as a result. I found myself digging into the research to back up my personal experiences with this calm, uncluttered environment. I found many studies, which led to more readings and thus began my interest in how classroom design can profoundly impact student and teacher performance.

### **Background to the Problem**

With an increasing need to optimize student learning in a time of major budgetary constraints, overcrowded classrooms, and an almost doubled teacher workload, teachers are becoming more and more aware of how the classroom's physical environment can impact student learning and thus their working environment and job satisfaction. It would be beneficial then to use the research available in these areas to design an optimum learning space for students

that does not demand excess money or time to implement. Purposeful classroom design created by the teacher is crucial to fulfilling this need and the need of the increasingly complex emotional and behavioural needs of our current student population.

### **Purpose of the Study**

In this paper, I will search for evidence of the cumulative effects of lighting, colour, space, and the overall quality of the classroom's physical environment on student learning and teacher success. This knowledge will then be used to create a step-by-step practical plan that teachers can use when personalizing their classroom spaces.

### **Research Question of Hypothesis**

In what ways does the physical environment of a classroom influence student learning and teacher efficacy? Is it a significant enough difference to persuade educators to take notice? Changing a classroom is a fairly common circumstance in the primary education field, but will reflecting current research on the effects of the physical classroom environment reach out to students and teachers in secondary school as well?

### **Importance of the Study**

It has long been a belief that a classroom's physical environment is a mirror to a teacher's pedagogy and level of dedication to his/her profession. I noticed changes in both my students' behaviour and within my own practice when I implemented environmental changes in my classroom. However, very few teachers or educational leaders recognize the ramifications that a classroom's physical environment can have on a student's ability to achieve optimum academic and behavioural outcomes. Even less has been noted on how this same physical environment can influence a teacher's ability to give effective lessons and to build a functional and dynamite community of learners. This is why it is important to delineate how specific aspects of a

classroom's physical environment affect both a teacher's ability to teach and a student's ability to learn.

### **Definition of Terms**

1. **Lighting**—The source of light available in the classroom. For example: lamps, windows, backlights, fluorescent vs. halogen vs. incandescent
2. **Colour**—The colour used on the walls as well as on furniture and containers within the classroom. Light colours vs. dark colours, warm colours vs. cool colours will be discussed.
3. **Space**—This will refer to the space allowed per student in square feet as well as in the total classroom square feet available.
4. **Traffic Flow**—This concerns the pattern of movement within the classroom and at times within the school as a whole. Traffic flow will vary from dense to light and is dependent on placement of school supplies and toys as well as doors, sinks, and coat.
5. **Neuroscience**—The study of brain chemistry and functions and involves several sub categories, such as neuropsychology.
6. **Physical Environment**—This encompasses all objects within the classroom and includes all of the above terms. Usually physical environment will include furniture, colour, lighting, sound, smell, flooring, traffic flow, and space.
7. **Universal Design**—This idea is best explained by J. Katz: “physical and instructional environments are designed so that students have access to differentiated learning opportunities in order to address their varied learning modes”(Katz, 2013).
8. **Environmental Awareness**—The knowledge of how the physical environment can and does affect learning and teacher efficacy and the understanding that the physical

environment is reflective and predictive of a teacher's pedagogy and teaching style. The realization that a student's learning can be positively and negatively impacted by the classroom layout, lighting, noise, colour, space, smell, and traffic patterns.

9. **Clutter**—"Clutter is the state in which excess items, or their representation organization, lead to degradation of performance at some task" (Rosenholtz, Li, Mansfield, & Jin, 2005, p. 1)

### **Scope of the Study**

This paper will explore the effects as validated through research of lighting, colour, space, and other sensory inputs as they pertain to the classroom environment. The study's focus is to understand the relationship between a student's learning and a student's working classroom landscape. I am also interested in how a teacher's potency can be magnified or diluted via that same classroom environment. Ultimately, my aim is to condense this research into practical ideas/solutions to be used by a classroom teacher regardless of the physical teaching environment in which they find themselves. I would like to create a blueprint for optimal classroom design cemented in scientifically grounded research.

### **Summary**

The impact of a classroom's physical environment is a pivotal factor in determining teacher performance and satisfaction. It also strongly influences a student's ability to learn, focus, and excel. If a teacher is able to change his/her classroom environment by implementing a few key understandings on how humans react to their environment, particularly concerning its use of colour, lighting, space, and other senses, then the teacher needs to learn how to do this, and subsequently, administrators and leaders need to understand the needs for both students and teachers to learn in environments that support that holistic learning and overall well-being. I am

hoping this research will allow an “in the trenches” educator to use current academic investigations to inform his/her practice and thus engender job satisfaction and subsequently improve the learning of our students.

### **Outline of the Remainder of the Paper**

In the coming chapter, I will be reviewing the academic literature outlining the effects of the physical environment on teacher performance and student learning. At times, the studies will be reflective of people as a whole rather than within a certain profession or stage in life. Fortunately there is a depth of knowledge already gleaned from years of research and investigation into how humans react to their physical environments. I will focus most research on how colour, lighting, and space can affect us and on a lesser level evaluate studies looking at smell, noise, and traffic patterns within a physical environment. The chapter will begin with colour and how its intensity, shade, and prevalence influence human behaviour in both children and adults. Next, I will delve into the studies investigating how lighting can be a positive or negative force in the classroom. I will discuss types of lighting as well as quality and quantity. Following this, I will review literature pertaining to space and how much is needed per person in different scenarios, but particularly within a classroom setting. Impacts on lack of space and its effects on behaviour will also be noted. Within these main sub headings I will interject ideas about smell, noise, traffic patterns, nature vistas, and furniture as seen in scholarly inquiry.

In Chapter three I will consolidate the aspects of this research to show what the optimum classroom environment will look like based on what research suggests is the best use of colour(s), lighting, and space, etc. These recommendations will also be illustrated in a table chart.

## **Chapter Two—Review of Literature**

“To live in an environment that has to be endured or ignored rather than enjoyed is to be diminished as a human being.” (Gauldie, 1969, p. 182)

### **Introduction**

As teachers we cannot control everything in our teaching environments. We cannot dictate the size of our classrooms or the height or our ceilings. We cannot govern whether our schools are near train stations or busy highways. We cannot change the materials used to build our schools or that shape our classroom walls. However, as teachers we can control the colours we use in our classrooms, the amount of furniture in our spaces, and the arrangement of said furniture. We can usually dictate the amount of lighting available and even to a minimal degree kind of flooring found in our classroom. In this literature review, I will highlight the effects of colour, lighting, and space on our student’s performance, physiologically and academically. I will also include studies showing how teachers interact with this same classroom space. Classrooms are truly a symbiotic relationship between a teacher, her/his students and each stakeholder’s success.

### **Colour**

Many accepted beliefs about colour are anecdotal and far from pure science. However, studies have shown that color can affect mood and emotions, stimulate the senses, cause physiological changes, and provide wayfaring cues in institutional settings. Color also has cultural overtones as specific colours hold diverse meanings in different societies. For example, white is seen as a symbol of purity and freshness in western cultures but for some Eastern cultures, white represents death. Generally speaking in North America, colours have these

assigned emotional attributes; red signifies anger/aggression, green equates to quietness, black denotes depression, yellow/orange means happiness, and brown depicts sadness. (Boyatzis & Varghese, 1994, p. 4,78; Tofle, Schwarz, Yoon, Max-Royale, & Des, 2003, p. 8)

Humans have developmental colour preferences, as well. Younger children in their primary school years are drawn towards warm yet bright palettes (coral, salmon, warm yellow, peach) while intermediate and secondary school aged children prefer cooler more subtle colours (medium toned blues, greens off set with grey, beige, or soft browns). In fact, as children age, their ability to filter out visual distractions decreases thus cueing their need for softer cool colours over brighter hues (Engelbrecht, 2003; Terwogt & Hoeksma, 1995, p. 16).

Children with disorders such as ADHD also respond to colour in their learning environments. These children work better in areas with warm neutral colours.(Engelbrecht, 2003; Gaines & Curry, 2011, p. 52) A study completed at the University of Alberta looked at the effects of colour on a small group of severely disabled children. The researchers found that when placed in a room painted with shades of cool blue, the children's blood pressure decreased, aggressive behaviour lessened by fifty-six percent, and the student's on-task persistence increased (Engelbrecht, 2003; Wohlfarth, 1986, p. 160).

Colour can also affect spatial perceptions. It can create a sense of spaciousness in a small area or make a large room appear compact. To this end, dark colours are believed to visually shrink a room while light colours reflect light, thus fashioning a sense of expanse (Tofle et al., 2003). An absence of colour or a monochromatic palette creates problems too. It can be "perceived as institutional ... [and] when viewed for an extended period ... leads to sensory deprivation, which leads to disorganization of brain function, deterioration intelligence and an inability to concentrate" (Tofle et al., 2003). Furthermore, white and off-white colour schemes

(with no variations in wall colours) were shown to decrease human efficiency by twenty-five percent in business environments (Engelbrecht, 2003) As a result, Engelbrecht recommended that classrooms remain neutral in colour yet create a focal wall (or end walls). “End wall treatments in a classroom can help to reduce instances of eyestrain for student by helping the eye to relax as student look up from a task. Studies suggest that the end wall colors would be a medium hue with the remaining walls a neutral tint such as Oyster white, Sandstone or Beige” (Engelbrecht, 2003). This change allows students’ vision to rest and reduces eyestrain while simultaneously stimulating a student’s brain.

In hospital and health care institutions colour is a valuable way to direct people to the correct areas. Departments and corridors are marked with clear colour differences, helping visitors, patients, and staff find their way (Dalke, Little, & Niemann, 2006; Read, 2003).

Colour theory also plays a role in students being able to easily see text in the classroom. Research has shown that high contrast colour (black and white) make it easier for students to discriminate letters while low contrasting colours such as grey and white reduce easy readability. An article in the journal *Behaviour & Information Technology* that studied the effect of text/background colour combinations on readability and behavioral intention found that of the 136 participants most found greater contrast was easier to read. The authors recommend that, “educational sites, where retention and readability, especially readability, are a major concern; black on white text should be used” (R. Hall & Hanna, 2004, pp. 22–23).

Another study noted that grouping like colours together could minimize visual clutter. In a classroom that could mean using bulletin board display colour in coordination with library baskets or furniture colours as well as using just a single colour family per poster or bulletin

display. This study found that in a display featuring multiple colours the brain doesn't know where to focus and therefore perceives clutter (Rosenholtz et al., 2005).

Colour can therefore have a profound affect on a student's ability to focus and/or become engaged in his/her learning. It has mood enhancing and societal cues embedded within its palette and creates physiological shifts within our learners.

### **Lighting**

Lighting can be achieved via artificial means or through direct/indirect sunlight. Research has outlined the importance of connecting these two elements. For example, the amount of light will directly influence the tint and hue of a colour. A red-toned colour can become purple when the light source is dim. Likewise the intensity of a colour can transform in the absence of light or in its abundance. Therefore one can impact the other and they must be studied and implemented as one combined environmental feature.

However, the ramifications of light within a room or building and even a classroom have been studied extensively and most studies confirm that an adequate amount of light, from both artificial (blue light and certain wavelengths) and daylight sources have proven positive physiological effects on the human brain. Its presence synthesizes Vitamin D, helps prevent cavities, and has shown to increase growth rates in children. Conversely, the absence of light or an insufficient amount of it can cause cortisol levels to rise. Cortisol is a stress-regulating hormone.

“Light has also been found to have an effect on the human neuroendocrine system and may also suppress melatonin and elevate cortisol production, both of which may have negative impacts... For example, blue light may improve cognitive performance; different coloured lenses may assist with reading difficulties such as dyslexia; and the human circadian system may be

particularly sensitive to short wavelength light” (O’Connor, 2011, p. 229). Classrooms that use inefficient fluorescent lighting (which flicker) or that have excessive daylighting (due to a lack of window covering) cause students and teachers to experience eyestrain, headaches, and “impaired visual performance”(Winterbottom & Wilkins, 2009, p. 71,74).

In addition, teachers ranked access to adequate natural lights as among their top three priorities when deciding on a classroom space. Thus having a source of natural light could influence teacher’s job satisfaction. In fact, students have shown a marked increase in reading (by 26%) and in math (by 20%) when placed in a classroom with adequate amounts of natural light (Heschong, Wright, & Okura, 2002, p. 106 & 110).

Another important consideration in lighting a classroom is creating as little glare in the environment as possible. Glare on shiny surfaces can cause eye fatigue and strain and thus contribute to off task behaviour. Shiny floors or shiny white boards, as well as glare on computer screens need to be minimized. Again, teacher control of this is essential.

Lighting is often overlooked when deciding on classroom design, but its presence especially when it can be directed or dimmed is a positive learning and physiological entity.

## **Space**

The impact of space on learning has been recognized by educational authorities. However, school administrations have yet to align their public school building expectations with the findings of educational researchers. In British Columbia (BC) and Ontario, the provincial governments have specific guidelines legislating the minimum amount of space per classroom based on the grade level of the students. In Ontario, a grade one to eight classroom must have a minimum of 750 ft<sup>2</sup> while the BC government demands 807 ft<sup>2</sup>.(Duncanson, Danbury, & Volpe, 2009, p.29; BC Ministry of Education, 2012a, p. 7; Ontario Public School Boards Association,

2010, p. 11). CK Tanner stated in his study that young children should have a minimum of 49 ft<sup>2</sup> each. He based this number on the amount of space needed for comfortable social interactions between acquaintances. Later, Duncanson found that space allowances for adults were inappropriate for children. Children have “horizontal sprawl” because they do not just sit and stand up, they use the floor horizontally and therefore need a bigger footprint. (Achilles, Duncanson, & Volpe, 2009) This means that our primary classrooms in British Columbia, which currently cap at twenty-four students, should be at least 1176 ft<sup>2</sup>! If this isn't physically possible he suggests limiting the number of students per class until it hits the optimal class size. For example in a classroom of 807 ft<sup>2</sup> the total number of students should be no more than sixteen. (C. Tanner, 2009, p. 1) Another study concluded that more space equated to higher standardized scores for hands-on science and questioning. (EF Duncanson, 2003). Tanner also found that this comfortable social distance increased as students aged and therefore high school students should be given at least 64ft<sup>2</sup> (C. Tanner, 2009).

In addition, space is defined by cultural expectations. As P. Gibson explained:

(E.T.) Hall first noted cultural differences in personal space use between what he called contact cultures (Latin American, Arab, and Mediterranean) and noncontact cultures (Northern European and North American). When people from contact cultures interact with people from noncontact cultures each may misinterpret the other on the basis of personal space. The individual from the contact culture may view his or her noncontact culture acquaintance as distant and aloof, whereas the individual from the noncontact culture may see his or her opposite as overly assertive or intimate. (Gibson, B., Harris, 1993, p. 180; E. T. Hall, 1966)

With Canadian multiculturalism these associations attributed to space could very well affect classroom interactions and learning.

Space is also a silent communicator. It is a telling sign of the teacher's priorities and teaching style. It can enhance learning and empower students. Conversely, the lack of space may lead to increased aggression, stress, and chaos. The BC government has just rolled out a new curriculum plan emphasizing collaborative, project based learning. This kind of learning demands group work, large open areas for exploration, and flexible furniture and space (Government, 2012b).

In fact, space even influences a student's ability to use higher-level critical thinking skills. A study by Achilles and others found that children would choose space according to the level of thinking required. "Low-level thinking took place at desks. Students worked at their tables when the task contained specific instructions limiting the ways in which students could respond and required low level thinking ... these conditions did not produce their best works. When activity directions called for high order thinking skills, students headed for wide spaces on the floor. Communication was animated as students collaborated, solved problems, and helped each other to learn new content and skills" (Achilles et al., 2009).

Teachers also respond to their physical working environments. S. Martin wrote that she felt "teachers should be taught to perceive the environment as part of the learning process and not just as furnishings, equipment, and walls" (Martin, 2002 p. 140). Later in her article, she states teaching styles were also affected by space within the classroom. Classrooms with less space and a higher density of students tended to be teacher-centered as students could not negotiate their classroom space easily to work in groups as desks were usually arranged in rows. On the other hand, Martin wrote that child-centred teaching most often occurred in classrooms

with good traffic flows, larger areas of free space, and defined learning areas (Martin, 2002 p. 152).

In a small sample study conducted for the New Zealand Ministry of Education, researchers found that teachers, especially primary teachers, rated size and flexibility of the space in their classroom as their number one priority.(Neilsen, 2004, p. 59) Teachers need storage of resources and multipurpose furniture and areas. Students need space for group work, exploration and discovery, individual work, storage, and privacy.

Traffic flow is another important regulator of space. Students need quick and easy access to different areas in the classroom. Ideally high use/interest areas (cloak room, pencil sharpener, circle area) should be along a main artery to and from spaces in the classroom. As Duncanson states:

A main avenue should start at the classroom door and run across the room parallel to one wall. Secondary paths should lead to special areas of the room (Federal Sign and Signal Corporation, 1974). Pathways, wide enough to allow two students to pass without touching each other, can be outlined on the floor (Colbert, 1997). A reasonable goal is for one-half of the classroom to be open space: space already outlined on the floor.

(E Duncanson, 2014, p. 4)

One case study conducted by Caroline Guardino found that simply rearranging classroom furniture and creating separate work areas with clearly defined learning spaces as well as improving traffic flow improved classroom behaviour immediately. (Guardino & Fullerton, 2010, p. 12) And again an earlier study by C. Tanner also found that, “special attention should be given to circulation ... that permit(s) student traffic to flow quickly from one part of the (classroom) to another” (Tanner, 2008, p. 450).

The use of floors as a viable seating/working area is also underserved in most classrooms (except for early primary). As mentioned earlier in this paper, Duncanson observed that children use space differently than adults and tend to use the horizontal field (floors) most often. As a result, learning flourishes for children when there is more open and empty floor space in the classroom (Duncanson et al., 2009). Teachers have reported that they prefer tiled flooring to carpeted flooring because of the ability to clean it better; however, students may not find this as comfortable because it is not soft and tends to be cold (Lang, 2002, p. 39).

Classroom furniture is directly related to available classroom space and subsequently needs to be considered in the overall design plan. In order to delineate pathways, provide easy access to instructional materials, define learning spaces, and to create empty spaces, classroom seating, tables, and shelving need to be well placed. (E. Duncanson, 2014, p. 37). The overall design should provide flexibility to “address the needs of a particular age group and any changing pedagogy ... [and is] needed to allow for different activities within the classroom and/or the needs of different users (Barrett, Davies, Zhang, & Barrett, 2015, pp. 119–120). New teaching pedagogy emphasizes collaboration and inquiry based learning. In fact, the new curriculum standards for British Columbia’s Ministry of Education specifically encourages a teacher to take ownership of his or her teaching space. “Many schools and teachers create learning environments that explore the use of time and space in creative ways ... learning and technology (has) opened the door for teachers and schools to approach the use of time and space in creative-ways that adapt to the students’ needs and interests” (BC Ministry of Education, 2015, p. 6). As a result, classroom spaces need to provide students and teachers areas for one-on-one instruction, small group instruction, and large group instruction. Chairs cannot be too heavy, tables need to move easily, and all areas of the classroom need to be accessible.

Another aspect of space in classroom design not often studied is one of “visual clutter”. A study conducted in 2014 by a group of researchers from Carnegie Mellon University placed kindergarten students in two different classroom environments. One classroom was decorated as a traditional classroom, complete with posters, colourful ceiling decorations, shelves, and children’s artwork, and so on. In the sparsely decorated classroom all materials not needed for the immediate lesson were removed. The children were taught three lessons in the sparsely decorated room and then three lessons in the decorated room. Their findings showed a clear correlation between student on-task behaviour and learning outcomes and visual stimulation within the classroom. Children performed better, listened more, and retained information more effectively when taught in the sparsely decorated classroom. (Fisher, Godwin, & Seltman, 2014, p. 7)

Space within a classroom is vitally important to student achievement, teacher efficacy and satisfaction, and successful pedagogy implementation. For these reasons, classroom size, space allowances per student, and the use/purpose of classroom areas, as well as each space’s flexibility to adapting to changing needs are essential when creating an effective classroom design.

There are several other environmental factors that have been studied in relation to student achievement and focus. Elements such as smell, temperature, and noise play roles in student and teacher success. In one study conducted by B. Akpınar, the aroma of pure lemon essential oil was used in a classroom and showed a positive statistical improvement (test scores rising from 1.10 to 7.03) in alertness, memory retention, and increased cognitive achievement (Akpınar, 2005, pp. 956–957). Conversely, poor temperature and noise controls negatively affect student and teacher efficacy by causing distractibility and thus lack of focus on the subject at hand. Cited

by Earthman (2004), the New York Commission on Ventilation found that the optimum temperature for classroom instruction was between (68-70°F) 20-21°C (p. 12). In addition, Earthman cites that temperature and noise issues are contributors to absenteeism among both pupils and teachers due to health concerns, such as asthma or headaches, which then reduces time in the classroom (Earthman, 2004, pp. 31–32; Higgins, Hall, & Wall, 2005, p. 35). Higher levels of noise, in particular, Earthman stresses, can “seriously hinder students from achieving their full potential.”

Lastly, several studies have reflected on the calming and stress-reducing effects of green space on students. In a study involving 360 students, an Australian team of researchers from the University of Technology (UTS) found that students in the middle and secondary schools showed a statistically significant increase (between 10-14%) in test results for Spelling and Mathematics. The only difference created was the gift of three plants per classroom (Daly, Burchett, & Torpy, 2010, p. 3).

Even having a vista of nature contributes to this sense of well-being. CK Tanner described how windows in classrooms provide a relief to students.

This relief is associated with window gazing and is less consuming than the focused attention used to draw pictures or doodle in a notebook. It is easier for students to refocus their attention back on the teacher when engaged in tasks requiring soft attention (such as window gazing) rather than those requiring more focused attention. (C. K. Tanner, 2009, p. 386)

A study conducted by the Heschong group found that classrooms with the highest window ration “were associated with 15 to 23 percent faster rate of improvement over a one year period” (Heschong et al., 2002).

### **Chapter Three**

#### **Summary**

When I first decided to delve into the research concerning classroom design and its effects on student learning and teacher efficacy, I believed there would be very little to analyze. I had not received any training on classroom design in my teaching degree. I had received no workshops highlighting its importance to my everyday practice. I knew only what I had gleaned from on the job experience, mentor teacher advice, and parent/student feedback. Yet, I soon discovered that there are a plethora of studies examining lighting in classrooms and delineating the space needed for optimal academic gains. Research on colour within schools, however, seems to be generalized and more subjective and less about the classroom experience. During my quest, I found other articles and scholarly inquiries into suitable classroom furniture, noise allowances, temperature, nature vistas, and even smell preferences. Slowly a picture of the ideal classroom began to emerge. This picture is open to interpretation as teacher pedagogy and personal taste as well as student consensus and needs should always influence any final designs.

#### **An Evidence-Based Ideal Classroom Should Look Like This**

Starting with space, our ideal classroom should allow for students to move around easily, have clearly defined traffic flows, ample empty floor space, and approximately fifty square feet per student. This amount of space per child allows the student to adjust his/her personal space as is comfortable (culturally and personally) and reduces stress levels caused by the feeling of overcrowding. In BC, the average elementary classroom (excluding kindergarten) has twenty-four students. That means we should ideally have a classroom with an area of  $\sim 1200\text{ft}^2$ .

Within this ideal classroom space there should be a number of discrete areas/settings and ample and varied seating. The seating should account for individual, small group, and large

group learning. The teacher's preference for student desk arrangements is individual but should take into account the need to create ample empty floor space and traffic pathways. Pathways to high congestion zones, such as to the pencil sharpener, the cloakroom, the entrance, or to the teacher's desk should be evaluated for ease of movement. Excess furniture not needed for storage or seating should be eliminated to allow for more space.

Flexibility in the modern classroom is key to enabling students to switch between group learning and individual study, between directed learning and inquiry. Different tasks require different seating and environments. Group work needs tables, or grouped desks, or space on the floor to assemble. Individual study or private time with the teacher needs less space but more intimacy. Furniture should then be able to shift easily (wheels would aid this endeavor). Floor coverings that provide comfort and warmth should be available for use by students in order for them to take advantage of the empty floor space. Portable lap desks, alternate hard surfaces for writing (such as the top of a short bookcase, or a standing table), and even a platform, designed loft-style would give teachers and students a larger use of the footprint of the classroom yet keep the floor space open and accessible.

The ideal classroom would also have ample lighting, preferably from natural light. Artificial light, when used, should be blue-toned and of a high quality. Lighting should be controllable by the teacher, meaning light switches for different areas of the classroom, dimmer switches, curtains or blinds. Reducing glare on surfaces is also important as this too causes eyestrain and makes it difficult to use our ever-increasing need for technology in the classroom. Shiny surfaces should be covered or given a matte finish when possible. Lighting appropriately (the ability to change the direction of the lighting from direct to diffuse) also helps to reduce glare.

In this classroom, colour would also take on a soothing supportive role within the classroom dynamics. The walls would be neutral in colour (beige, or grey), but depending on the age of the students the end walls would be coloured with either a warm bright colour (kindergarten and lower elementary) or a cool medium-toned hue (upper elementary and high school). Visual clutter from student artwork or informational posters will be kept to a minimum and when displayed pertain directly to the lessons at hand. Bulletin boards will be created using one colour family. Important text will be written in high contrast yet pleasing colour combinations. On whiteboards, handouts, or tests the best colour combination would be black text on a white background.

Outside noise should be muted if possible and if not then diluted through the use of a soothing environment sound such as low music or a water fountain. Smells too should be neutralized or based on pleasant smells familiar to the overriding culture within that classroom.

Carpet is a great sound inhibitor and could be used to deaden echoes in rooms that have hard reflective surfaces. Abundant use of soft furnishings such as floor rugs and pillows will also help achieve this sound-absorbing effect. Quiet times during instruction should be encouraged as too much noise has shown to be detrimental to retention of information and causes physical side effects such as headaches. Creating functional traffic flows and adequate empty floor space would prevent many potentially loud moments in the classroom due to congestion. Control of the classroom temperature should also ideally be within the teacher's grasp rather than mandated centrally by the school district. In addition, nature will be invited into the classroom space with homes made for at least three plants and views to the outside world will be unobstructed.

If the teacher is able to influence his/her classroom environment using this evidence-based approach, literature corroborates that the teacher will feel career satisfaction and a sense of

ownership. He or she will positively affect student academic performance and support well balanced social interactions within the classroom. Teachers will then feel like they can determine the success of their students, are able to personalize their space, can create attentive and engaged learners, and thus grow as professionals.

### **Limitations**

Despite the abundance of research on individual concerns such as lighting, colour, and space, there are few studies examining the combined effect of these elements in a classroom. Student outcomes are the result of a complex series of interactions with these elements. How can we separate teacher experience and competency from the equation? How can the overall school culture, the socio-economic factors of its population, or the amount of parental involvement in each school be isolated from any research-based study except via an extremely large size survey study involving student/staff perceptions about classroom design and multivariate analysis? Can students within this recharged classroom be compared to students in the control environment, particularly as they most likely have a different teacher? Should in-class time, itself, be limited—with more student time taking place in the outside world, surrounded by nature? Finally, a major obstacle to research on classroom design is the fact that it is unethical to provide one set of students with a classroom believed to be optimal for learning and then not provide that same environment for other students resulting in any such study being vetoed by an ethics review board or school district.

### **Future Research**

Research needs to look at each strand contributing to student success in a classroom. It needs to identify not just if lighting affects learning but also how much lighting is needed, what kind of light is optimal, and if placement of lighting should be prescribed. Future research needs

to experiment with classroom seating arrangements to establish which order is best for each style of teaching and activity. The kind of seating which generates the most comfort in an educational setting also needs to be investigated. Future research concerning smell and its effects on student attention should be examined as well as studies on the ability of student's to filter out both background noise (air conditioners, furnace), and student talking. Is there a decibel level at which learning stops or is improved?

### **Recommendations**

Despite the lack of research on the entire physical environment and its relationship to student learning and teacher efficacy, the culmination of the present studies clearly shows its statistically significant influence on learning. Unfortunately, teachers remain largely unaware of the impact their classroom's design potentially has on their practice. Most research suggests that the teachers who do alter their classrooms feel a sense of ownership and empowerment. By that same token, students who are made a part of the process, anecdotally, also feel more engaged.

Teacher training programs need to integrate courses on classroom design into their education programming. Professional development within schools and school districts should also provide opportunities for teachers to learn about the design implications of their classroom environments.

Parent education could also help us transition classrooms to a more user-friendly format. Their help in fundraising for the necessary equipment and their expectations that schools will provide the best learning environment will create positive pressure thus allowing teachers to actually gain the resources to implement an ideal classroom. To motivate teachers, an incentive system grounded on remodeling their classroom (such as a stipend) or time paid to attend

workshops or work with a mentor could help transition a district to this evidence-based approach to classroom design (Lang, 2002).

## **Conclusion**

For three years I have basked in the comfort of teaching and working within the same classroom, the same school, and in the same grade. This is a first in my sixteen years as a teacher. In fact, I have moved rooms and schools so often that I have taught in five schools and nine classrooms in the last eight years. I have always enjoyed creating my classroom each year and have learned from each design I developed. Over time my classroom style evolved. Initially, I worked from peer advice and the experiences drawn from my day-to-day teaching. After my accident, I began to research the physiological effects of the environment on learning. I then began to look at my classroom environment as one in which I could not only positively influence my student's academic success, but also enhance my own teacher performance and peace of mind. My classroom aesthetic was no longer just about beauty, but also about giving my students every advantage, backed by research, that I could possibly give within our little world.

Ironically, I now find myself stepping into the classroom designer role yet again. Next year, I will once more establish my classroom in a new school with a set of unknown students and within a new school climate. I will once again study the physical environment I am given, analyze the room for structures I can change and determine what I cannot. I will adjust lighting. I will personalize the colours for my now upper intermediate student needs. I will plan for many varieties of seating. I will look for how traffic patterns can be optimized. I will create a calm, safe, stimulating, nourishing, focused, and welcoming space. My students will learn and so will I, gracefully, and with respect for our mutual environment.

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**Table 1: Quick Reference to Optimum Physical Environments for Classroom Educators**

	<b>Descriptor</b>	<b>Grades K-6</b>	<b>Grades 7-9</b>	<b>Grades 10-12</b>
<b>Colour</b>	Warm/Cool Tones	Warm	Warm/Cool	Cool
	Bright/Soft	Bright	Soft	Soft
	Disliked colours	Brown, Black		
	Liked colours	Peach, coral, warm yellow	Mid-blues, mid-greens	
	Preferred Colours-Special Needs Children	Warm/Neutral (Beige, Grey, Soft Yellows) Although shades of cool blue are also beneficial		
<b>Visual clutter</b>	Scale of Distractibility	Very Distracting	Distracting	Less Distracting
	Special Needs Children	Very Distracting		
<b>Lighting</b>	Daylight	Recommended		
	Fluorescent	Can cause physiological effects (headaches, eye fatigue) if they are low grade/inefficient causing flickering		
	Customizable <i>(Daylight and artificial lighting can be changed to suit purpose and individual needs)</i>	☐	☐	☐
	Colour of Lighting	Blue lighting was universally liked and less visually disturbing		
<b>Space Per Student (ft<sup>2</sup>)</b> <i>Based on comfortable social distance between acquaintances</i>		49ft <sup>2</sup>	64ft <sup>2</sup>	64ft <sup>2</sup>
<b>Maximum Students Per Class</b> (*Given Space Allotment in BC Schools)		K (*968ft <sup>2</sup> ) = 19 Gr.1-6 (807ft <sup>2</sup> ) = 16	861ft <sup>2</sup> = 13	861ft <sup>2</sup> = 13
<b>Teacher Desk</b>		Eliminate if possible	Eliminate if possible	Keep area to a minimum
<b>Open Space</b>		50% of available space should be empty floor space (UK Parliament)		