(RE)-ENVISIONING CLASSROOM DESIGN WITH LIGHT AND COLOUR

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ABSTRACT

The purpose of this study was to determine if there was a relationship between the learning environment and student achievement and behaviour while journaling, and to learn if a teacher could control these conditions to produce an optimum environment for students. Incandescent and fluorescent lighting conditions were examined in the study, along with blue and red colouring. The semi-structured, action research methodology employed a quantitative analysis of the data with a small (n= <20) sampling of students over a nine-week period. The participants in the study were English 10 students from a small northern British Columbia high school. The literature examined the context of building philosophy, public policy, school and classroom design, and highlighted the impact of environmental elements on students and learning. The data indicated that alterations to colour produced greater change in student responses than changes to lighting alone, and that red colouring, when combined with incandescent, fluorescent and day light, produced highest achievement, although student satisfaction and teacher perception levels remained correspondingly low. The study concluded that red colouring led to increased distractedness levels for students, and that the teacher could cause measurable changes to student learning behaviour and achievement by altering the classroom environment.

Keywords*: Classroom design, color, light, environment*

INTRODUCTION

The purpose of this paper was to examine the research on principles of architectural design and the effects of colour and light in the learning environment to determine how public school teachers can create classrooms that best meet the needs of students in the 21st century. For many decades, government ministries of education, architects, and public school planners have been aware that the designed environment of schools is inexorably linked to student well-being. Within this context, the quality of lighting systems, and the application of colouring in learning spaces, each contribute to this sensory dialogue between the designed environment and the student experience. Classroom teachers are like architects and city planners whose task is to create healthy environments for learning within a context of community. Every day, teachers debate the level of comfort desired and set out to best establish these options within the limiting framework of financial constraints, existing structure, resource deployment, and other political, social, and security dimensions. Alterations to layout and design in a learning space may result in varying effects to learning, achievement, motivation, and engagement. Specifically, colour and lighting changes may lead to improvements in the learning environment, and measurable changes in student achievement. It is relatively easy to change colouration versus the overall design limitations of a space. This project examined notions of design, lighting and colour, and tested the impact of these environmental factors on learning conditions through action research that produced quantitative data.

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RESEARCH RATIONALE

More than a century ago, John Dewey, facing classrooms that were industrially modelled and mechanically void of free spaces for students, loosened and tore the very desks found bolted to the floor and insisted that such restrictive learning environments would never do (Bowen, 1981). Such an epiphany may again re-conceptualize our learning environments during an age that is seeing the brick-and-mortar school model dissolve into an iPad and SMART Board-oriented technology nexus. Before transformative, virtual schools become the mainstay of everyday learning in public schools across North America, teachers must be liberated from compromised environments that provide only small opportunities for change. Efforts to study and improve lighting conditions in classrooms have never been more necessary in the changing, modern dynamic of technology-driven design. Winterbottom and Wilkins (2009) noted that finding causality between the environment and student learning remains difficult due to the ethics of establishing a control group for clinical testing. For this very reason, action research was employed for this study.

SIGNIFICANCE OF THE STUDY

The purpose of the study was to learn if students responded to changes in lighting and colour in measurable ways, and to learn if these responses (if any) could be controlled by the teacher to produce positive effects on student achievement or learning behaviours during journaling tasks. Specifically, the study sought to learn if either blue or red colouration produced a more beneficial effect to the learning environment, and to see if students exhibited changes in responses when writing with either fluorescent, incandescent, daylight, or a combination of lighting sources. Teachers are inundated daily with the demands of the 21st century workplace that sees students accommodated in classroom environments that are more suited to a 19th century mentality of assembly-line production. As learning space design evolves in the 21st century, notions of experiential and hands-on learning in environments outside of schools contribute to the decline of the brick-and-mortar school. Through an emerging technological and political discourse, stakeholders of education are continuously directed by new trends and ideas to seek answers to a pervading question: what should schools look like to meet the needs of students? The study poses significant interest to practicing teachers who wish to make changes to the learning environment that are research-based, because it models an action-research mode of inquiry that teachers may find useful in their own practice.

THEORETICAL FRAMEWORK

This research presents a background to the fundamentals of design theory as it relates to the design of public schools, with a focus on the research available that links environmental conditions to student wellbeing and learning. The research investigates government policy and the impact of funding levels on the educational landscape, and outlines the evolution of educational theory and school design since the 1950s and suggests research-based steps for teachers to improve classroom design. Next, the paper explores design theory as applied to the school environment and classrooms in particular, and then overviews environmental factors related to the creation of comfortable learning environments, with a focus on colour and lighting as they affect classroom conditions and students in public schools. Many environmental elements affect the learning space, such as acoustical properties, size, ceiling height, ergonomics, materials used, proximity to exterior sound, temperature control—in addition to colour and lighting. The research in this paper examined a variety of environmental elements and concentrated on lighting and colour conditions within the framework of intelligently designed spaces. The research overwhelmingly reveals that light and colour, as well as many other environmental factors, impact classroom environments.

While colour may affect the behaviour of learners, Stone (2001) found that "positive" moods are frequently generated by environmental conditions, while "negative" moods were more a product of onerous lesson planning—a finding which implies that uplifting design spaces may improve satisfaction levels. In summary, the literature review shapes the research on colour, lighting, and effective school design into a framework of understanding to prepare an actionable context for the research project. Specific lighting and colouration within a context of appropriate design can enhance learning conditions, and both subtle and profound changes to a classroom can affect students. Despite limitations, teachers can employ specific changes immediately in their classrooms to improve conditions despite fiscal and architectural impediments.

DESIGN AND METHODOLOGY

This study examined to what degree colouring and lighting in the classroom created conditions to the extent that learning was best supported. The study pursued answers to the following research questions:

1. Did lighting and colouration changes in the classroom affect student achievement?
2. Was there an optimum colour/lighting combination for classroom-based journaling?
3. Could teachers control lighting and colour to produce measurable improvement in student learning?

The study required ten months, from initial approval until submission. During the course of nine weeks, eighteen observation periods of student journaling activities lasting 30 minutes each were conducted testing nine distinct lighting and colouration conditions to determine the effects of lighting and colour on student writing. The environmental conditions were arranged as follows:

1. Default colouring with fluorescent (full-spectrum) lighting and daylight (baseline).
2. Blue colouring with incandescent lighting only.
3. Default colouring with incandescent lighting only.
4. Blue colouring with fluorescent (full-spectrum) lighting only.
5. Red colouring with incandescent, fluorescent, and daylight.
6. Red colouring with fluorescent (full-spectrum) lighting only.
7. Default colouring with incandescent and fluorescent lighting only.
8. Red colouring with incandescent lighting only.
9. Blue colouring with incandescent and fluorescent lighting, and daylight.

During each test period the sampled group completed two journaling tasks. The data collection concluded after a nine-week period. Journal entries were assessed using a three-point rubric, which gauged length of response, topic permeation, and peer editing as indicators of achievement. At the conclusion of each week, students completed a checklist to record observations of student activity. Finally, students completed a Likert scale student survey at the conclusion of each test period to gather individual student data for each of the environmental conditions. The survey produced quantitative data as a reflection of student experiences following the conclusion of each environmental change to measure comfort and suitability of the environment with the task of writing.

Selection Process

The participants involved in this study were fifteen English 10 students from a class size of 27 students. The community supported a blue-collar, trades-based economy of approximately

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3,500 occupants servicing 5,000 occupants overall of varying socio-economic backgrounds. The majority of students were from an evenly split Aboriginal and Caucasian background. Fifteen students from the class were selected at random. The small sample was in part due to a number of outlier students who were completing modified programs, as well as students whose parents had excluded them from the study. The high school was located in the northern interior of British Columbia, Canada. Before conducting the study, I collected letters of information with signed consent forms from parents informing them of the goals and objectives of the study. Additionally, the school administration was informed of my intention to conduct the study and granted me written permission, and the school district also provided written consent for the research to be conducted.

Data Collection and Analysis

This action research project generated quantitative data for analysis. During the eighteen semi-structured observation periods, in which nine distinct lighting and colour environments were studied twice per week over nine weeks as outlined above, three pieces of quantitative data were gathered in this action research project: a journaling rubric, a checklist, and a Likert-scale student survey, to produce a triangulation of data. Gathered data was triangulated to produce correlations of student behaviours, teacher observations, and achievement scores. The data were analyzed using Microsoft Office Excel 2008 for Mac to generate descriptive data (mean, median, standard deviation, percentage distributions) and comparative graphs and tables. To analyze and interpret the data, individual questions from the survey and the checklist were used in correlation with the achievement data from the journaling rubric data, with the results explained where the data showed either a negative or positive indicator. The data was categorized according to differing patterns that highlighted overall achievement, perceived success in a given environment, and perceived comfort. Colour and lighting data were examined separately, and in combination, insofar as the checklist and student survey data permitted. Data showing student perceptions were gathered through the 1-5 Likert scale used in the survey, which indicated agreement levels. All percentages were based on the median of the raw values and not based on other percentages. The data collected via the student surveys was transposed onto an Excel spreadsheet. Using Excel, the data was calculated to find mean, standard deviation, and median scores by student, and by week of the study, and graphs were generated using the software. Median scores rather than mean scores for Likert-scale data were reported solely, unless the mean showed further distinction in the data.

FINDINGS

Students did not express a preference for any particular lighting condition as an isolated factor during the study. Participants indicated that they were most distracted when red colouring was introduced to the environment, however no result was found on the question of which colour and lighting combination most improved concentration or comfort levels when the median values were examined. The sample reported the lowest self-efficacy levels with the introduction of blue colouring. When red colouring was combined with all lighting conditions students scored the highest achievement scores in the study.

Research Question #1: “Did lighting and colouration changes in the classroom affect student achievement?” was partially confirmed in the study. Students in the study sample, undoubtedly, were impacted by changes to the environment. The data showed that students who routinely achieved high marks in writing journal entries were not affected by alterations to lighting or colouration. This may suggest that for students with a high degree of writing ability, alterations for lighting and colour produce little or no measurable effect on

achievement. The inverse possibility—that lower achieving students have the most to gain from changes in environment—is also a possible conclusion. This may also indicate that lower-achieving students are more susceptible to distraction than higher achieving students. The data also showed a surprising result: students can be distracted but also achieve high scores when journaling.

Research Question #2: "Was there an optimum colour/lighting combination for classroom-based journaling?" was at least partially confirmed when "optimum" is defined either in terms of comfort or in terms of achievement. However, in terms of calculating an optimum condition for lighting and colouration in the classroom, this study found that there are multiple ways to define "optimum" and as such, it is difficult to identify one approach. However, when achievement was the end goal, the study found that red colouring with fluorescent, daylight, and incandescent lighting, was optimal. Most students also found that red colouring with fluorescent, incandescent and daylight conditions was distracting. This finding indicated that the relationship between comfort and achievement scores was inversely proportional, at least to an extent. This challenged the assumption sometimes espoused by teachers that blue colouring is better for students, at least in terms of achievement, during writing tasks.

Research Question #3: "Could teachers control lighting and colour to produce measurable improvements in student learning?" was confirmed. Students measurably responded to changes in colouration and/or lighting. Changes to lighting conditions alone produced a measurably lesser effect on achievement in writing tasks. In particular, three students who exhibited consistent mastery of writing tasks did not alter in achievement at all despite any change to lighting or colouration, which suggested that strong writers were not be the beneficiaries of altered environmental conditions. The research did not find a substantive relationship between blue colouring and increased comfort levels. As indicated in the literature of the study, research has shown that blue is calming and red is stimulating (Sinofsky & Knirck, 1981; Wohlfarth, 1986; Grangaard, 1995; Holzman, 2010). The study showed that a teacher could alter colouring and lighting and produce measureable changes—improvements as well as detriments—to both student achievement and student comfort levels. Students identified both fluorescent lighting and incandescent lighting as equally suitable, but they did not indicate which source of illumination they favoured most. This discrepancy suggested that perceived comfort was not the same for teachers as it was for students.

Unique Contributions

The study found that teachers can control factors in the learning environment, but care must be taken to ensure the right decisions are made. The data showed that the teacher may not always correctly judge how students perceive colours in the classroom. In fact, the data showed a curious inconsistency between the teacher checklist data and the reported student data on the question of distractedness. The research did not find a correlation between student and teacher perception of distraction. The study also found that average achievement scores increased over the baseline (white) conditions, indicating that students prefer pronounced colouration to a neutral colour palette. The study also found that alterations to colour produced higher levels of change to student achievement and perception than did changes to lighting conditions alone. Therefore, it is valuable for teachers to alter the colouration of environments.

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RECOMMENDATIONS

It is easy to be wrong-headed when altering classroom environments to suit students better. And yet, the data finds some correlation between creating change in the environment and achievement scores. To colour learning spaces based upon what emotions these colours create in us is like "writing poetry based on the knowledge of the alphabet" (Pile and Friedmann, 1970, p. 52). There are many myths and unsubstantiated claims about the effects of colouration on the occupants of a space. While it is inadvisable to blindly adjust environmental conditions in the hope of stumbling upon an optimum condition, teachers should feel comfortable engaging in action research with their students, and using research-based approaches to classroom design. A poorly designed learning space is the proverbial elephant in the room that impacts our students in far-ranging ways that we should both be knowledgeable of and responsive towards. Colour and lighting choices should be aligned with learning outcomes to maximize benefit to students. Constructed environments for learning require balance. Achievement is not always the end goal of schooling—creating the whole individual who is self-actualizing, empathetic to others, confident, secure, and able to express who they are without limitation by environments—these, too, are concerns for educators who seek to foster lifelong learning in students. Teachers can choose from a range of optimum conditions for journaling depending on the intended outcome – comfort or high scores.

CONCLUSION

Students may not like changes to their environment, even if these changes improve the environment. Teachers may choose to optimize conditions without considering this possibility. Teachers should also be aware of what their learning objectives are with students when creating environmental conditions. Classroom colouration and lighting decisions should be research-based, but they must also be a collaborative process wherein the input of students is incorporated in the design of a learning space in the same way the needs of a client are integrated into the final design that the architect submits for approval (Imrie and Hall, 2001). By placing students into the driver's seat of design, as is the case in the modern PBL classroom, we retool schools to suit the principal users of the space. Red colouration appeared to reduce concentration measurably, while seemingly leading to improved achievement scores. While the data did not suggest with any authority that blue colouring is more calming than red colouring, blue colouring was shown to be less distracting. As the brick-and-mortar school concept continues a process of erosion and transformation into the 21st century, the need for designed spaces that respond effectively to diverse, changing learning styles grows ever prescient.

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