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THE EFFECT OF COLOUR ON STUDENTS' LEARNING EXPERIENCE AND CREATIVITY IN DESIGN SCHOOLS

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Abstract. Research indicates that colours used in learning environments can influence student performance in terms of creativity. However, the impact of different shades of classroom walls affect students' learning experience regarding creativity and willingness in a design school has not been explored in past research. This study aims to analyse the effects of various colours on students' creativity in a design school based on hue, chroma, and value attributes. The colour of the walls has a unique effect on how successfully college students perform in the classroom. This study built six virtual classrooms with red, blue, and green walls, each with two distinct values and chroma, to determine a good wall colour to encourage creativity. College students' perceptions were also gathered at the same time. According to the subjective survey, the colours green-yellow (105, 131, 130) and blue-green (48, 132, 154) on the walls had a mildly positive effect on the students. In contrast, green-yellow (114, 127, 82) and blue-green (37, 150, 190) positively impacted the student's ability to focus and desire to work. Red (196, 88, 88) and red (231, 49, 69) had a negative effect on the students. These findings highlight the potential of carefully chosen colours to enhance the learning environment and improve student outcomes in design schools.

Keywords: colours, creativity, design school, learning experience, student performance.

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1. Introduction

Colour can significantly impact a space's overall environment, affecting everything from mood and behaviour to academic performance and creativity. In design schools, where students constantly learn and create, colour can enhance the educational experience. Research has shown that colour can affect students' mood, behaviour, and academic performance. For example, warm colours like red, orange, and yellow can stimulate energy and creativity, while cool colours like blue and green can promote calmness and relaxation. Studies have also found that different colours can affect cognitive processes like memory and attention, which are critical to learning. In design schools, colour should reflect the type of creative work being done in the space. For example, a classroom where students learn about graphic design may benefit from using bold, bright colours that inspire creativity and energy.

On the other hand, a space where students learn about interior design may benefit from using more subdued, calming colours that promote focus and attention to detail. It is also

essential to consider the cultural and psychological associations that different colours may have. For example, in some cultures, red is associated with luck and prosperity; in others, it may symbolise danger or warning. Similarly, shades of blue may be associated with calmness, sadness, or trustworthiness. Overall, the use of colour in the interiors of design schools should be carefully considered to create a supportive and stimulating environment for learning and creativity. It is essential to consider the specific needs and goals of the space, as well as the cultural and psychological associations of different colours.

The study focuses on colour perception and its impact on students' creative thinking in an institutional setting, especially in design schools. The past research has not addressed the correlation between colour and creative thinking in design schools, which is a significant contribution to this research. Design school students' perceptions and responses were recorded through their virtual experience in a virtual reality laboratory set-up. Findings showed that the colours had shown a significant impact on the creativity and cognitive skillsets of students.

2. Background study

2.1. Past theories on colour perception

Blue light, *green light*, and *red light* are terms for short, medium, and long waves, respectively. All light comprises various wavelengths, converted into multiple colours and colour combinations. Rods and cones are structures in our human eye that help absorb specific light wavelengths and consider colour vision, which helps with colour perception in the brain. When light waves enter a person's eyes, the hypothalamic midbrain region, which regulates hormone production and release, is activated. This helps us know how comfortable a person is with the colour they perceive. Most kids reach complete colour vision around the age of fifteen. Individuals' physiological and emotional responses to colours might help them focus their attention and, as a result, learn new things (Al-Ayash et al., 2016).

2.2. Colour theory

Human perception strongly influences colour, often used to express aesthetic features. It can emotionally influence people's interpretations, memories, and reactions (Figure 1). Different messages are conveyed depending on how much of one or more colours are present – a technique closely related to mental and emotional states. Various professions are trying to understand the nature of colours, how they are created, how people perceive them, and how they affect people's lives.

von Goethe (1970) developed a colour wheel to characterise complementary colours based on physiological perceptions and psychological considerations (such as moral connotations and symbolic and mystic uses of colour). The chromatic circle is organised such that it follows natural order because the colours opposite to one another simultaneously stimulate one another in the eye. As a result, all intermediate gradations mutually evoke one another; the more precise colour requires the compound and *vice versa* (Sartori et al., 2015).

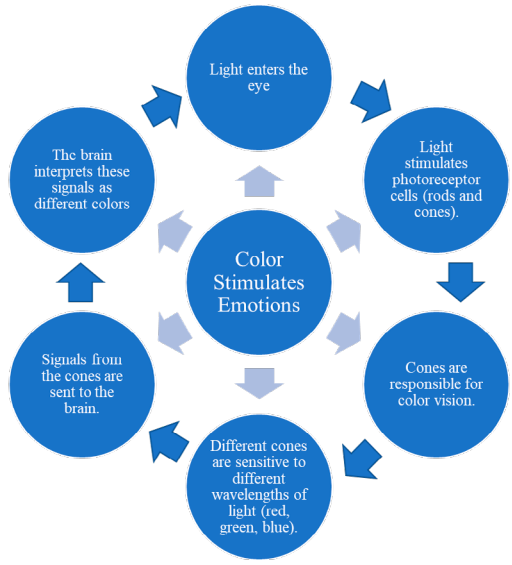

Figure 1. Model analysing how colour stimulates emotions in humans (source: created by authors)

2.3. Colour and student performance

Flexibility, complexity, and colour influence student performance and the learning experience (Salary et al., 2018). Students spend significant amounts of time in learning environments where a poor indoor environment could affect students' learning experience (Fakhari et al., 2021; Haverinen-Shaughnessy et al., 2015):

- Colour can affect mood and creativity. A study (Yildirim et al., 2007) published in the journal *Building and Environment* found that warm colours like red and yellow can increase arousal and energy levels. In contrast, cool colours like blue and green can promote relaxation and calmness. This suggests that using warm colours in areas where creativity and brainstorming are encouraged, such as design studios, could be beneficial;
- Colour can affect cognitive processes. Research has shown that different colours can affect cognitive processes like attention and memory. For example, a study (Miller et al., 2021) published in the journal *Contemporary School Psychology* found that blue walls can enhance students' performance on tasks that require attention to detail. In contrast, red walls can improve performance on tasks that require creativity and idea generation;
- Colour can affect academic performance. A study (Diachenko et al., 2022) published in the journal *Heliyon* found that students performed better on tasks when surrounded by red. At the same time, blue surroundings were associated with lower performance. This suggests that using red in areas where students are expected to perform cognitively demanding tasks, such as taking exams, could be beneficial;
- Colour can affect perceived comfort and satisfaction. A study (Stoesz & Niknam, 2022) published in the *Canadian Journal of Learning and Technology* found that students rated rooms with warm colour schemes as more comfortable and inviting than those with

cool colour schemes. This suggests that using warm colours in common areas, such as lounges or waiting areas, could improve students' overall satisfaction with the school environment.

2.4. Exploring colour psychology and its impact on users

Several studies have examined how the use of colour in interior design can affect the performance and behaviour of students in institutional set-ups. The past literature is summarised below (Table 1).

Table 1. Colour psychology and its impact on users (source: created by authors)

	Title of the publication	Author(s)	Year	Key finding	Inference	Cite
1	"Establishment of Emotional Database and Extraction of Color Psychology of Children from Images"	Seong-Yoon Shin	2019	Children prefer brighter colours	This has been done by going through many research papers	Shin, 2019
2	"The World of Plants in Children's Drawings: Color Preferences and the Effect of Age and Gender on These Preferences"	Berat Ahi	2017	Apart from green, the surface areas were covered by light blue, red, yellow, grey, orange, and white, respectively; Mostly, boys preferred making use of colours like red and blue.	Colour preferences change with gender; Explores the colours children chose for a drawing they are asked to do.	Ahi, 2017
3	"Colour and Emotion: Children also Associate Red with Negative Valence"	Sandrine Gil, Ludovic le Bigot	2016	Study how colours affect children and how red colour affects them	After a small activity was performed, it was concluded that the colour red hurts children	Gil and le Bigot, 2016
5	"Enhanced Enjoyment and Creativity by Positive Stimuli: Color, Light, and Sound in an Art Activity Space of the National Gallery of Thailand"	Khorawan Ngamvoratham, Thanin Ratanaolarn	2020	Blue – liveliness, orange – warmth, cheerfulness, and enthusiasm; Warm tones of colour, including red, orange, and yellow, induce awareness and spirit; Cool tones – blue, light blue, purple, and green cause a relaxed feeling.	Warm colours – awareness and liveliness; Cool tones – relaxed feeling.	Ngamvoratham and Ratanaolarn, 2020

Continue of Table 1

	Title of the publication	Author(s)	Year	Key finding	Inference	Cite
6	"The Influence of Color on Student Emotion, Heart Rate, and Performance in Learning Environments"	Aseel Al-Ayash, Robert T. Kane, Dianne Smith, Paul Green-Armytage	2016	Hue influences heart rate; Pale colours were more calming as compared to vivid colours.	Age affects colour preferences and how it affects their emotions	Al-Ayash et al., 2016
7	"The Effects of the Wall Colors Used in Educational Spaces on the Perceptual Evaluations of Students"	Menşure Kübra Müezzinoğlu, Mehmet Lütfi Hidayetoğlu, Kemal Yildirim	2020	The "spatial quality" positively affected the cool-coloured spaces more than the neutral-coloured room	These findings lead to the recommendation that chromatic hues, rather than achromatic ones, should be used in the design of educational environments so that students will evaluate them favourably and generate better impressions	Müezzinoğlu et al., 2020
8	"The Effect of Color in Designing Instructional Aids on Learners' Academic Performance"	Nidal Amarin, Amna Al-Saleh	2020	Bright colours like yellow and blue – upbeat, vibrant, and energetic; Blue colours, black or grey – depressed or sad; Red and orange – anxiety.	Age and gender need to be considered	Amarin and Al-Saleh, 2020
9	"Unifying Research on Colour and Emotion: Time for a Cross-Cultural Survey on Emotion Associations with Colour Terms"	Christine Mohr, Domicele Jonauskaite, Elise S. Dan-Glauser, Mari Uusküla, Nele Dael	2018	It explains how different colours can mean things to people across many cultures and countries.	It explains how different colours can mean other things to people across many cultures and countries.	Mohr et al., 2018
10	"Designing Creativity-Enhancing Workspaces: A Critical Look at Empirical Evidence"	Martin Meinel, Lukas Maier, Timm F. Wagner, Kai-Ingo Voigt	2017	Sterile settings devoid of colour are detrimental to creating the effect of colours on creativity depending on individual perception	How colours impact people could be different based on how they perceive them	Meinel et al., 2017

End of Table 1

	Title of the publication	Author(s)	Year	Key finding	Inference	Cite
11	"Investigation of Color-Emotion Associations of the University Students"	Ümit Demir	2020	White, blue, and red were the hues that the participants perceived as being the most optimistic; The gender and academic education departments showed substantial variances; Red, black, white, grey, and purple hues varied depending on gender, whilst red, blue, and purple colours affected the education department.	Not much research has been done on how these colours affect creativity; How these colours can be used in a design school has not been explored; How different shades of colours impact students can be explored.	Demir, 2020

In design schools, understanding the impact of colour psychology is crucial for creating effective designs that resonate with the target audience. While exploring colour psychology in design, one needs to consider the following principles:

- Colour associations. Different colours can evoke different emotions and associations in people. For example, red is often associated with passion, energy, and urgency, while blue is associated with calmness, trust, and reliability. The hue and degree of whiteness of colour have a considerable influence on its effects since they have a soothing effect and are commonly rated highly by people. Colour affects heart rate; it increases in the presence of red and yellow hues and decreases in blue hues. According to studies, the colours yellow and blue elicit positive sentiments (Al-Ayash et al., 2016). Understanding these associations can help designers choose colours that align with the desired message or brand image;
- Cultural differences. The meaning and associations of colours can vary across different cultures. For example, while white is often associated with purity and cleanliness in Western cultures, it may represent death and mourning in some Asian cultures. Designers should be aware of these differences when designing for a global audience;
- Context matters. The context in which one employs colour can also affect its influence. For example, a bright, bold colour scheme may be appropriate for a youth-oriented brand but not for a professional services firm. Designers should consider the target audience, industry, and overall tone and message of the design when selecting colours;
- Use of colour in design. Besides the psychological impact of colour, designers should also consider the practical aspects of colour use in design. For example, high-contrast colours can help with readability and accessibility, while limiting the number of colours used can help create a cohesive and visually appealing design;
- Colour and education. In interior design, colour choices are highly personal and can evoke different emotions in each individual. Colour selection is critical in public venues such as academic libraries or learning spaces to create a functional and practical atmosphere (Aminian, 2017). As blue-coloured classrooms are seen more favourably in terms

of happiness, spaciousness, tranquilly, and comfort than cream and pink-coloured classrooms, pale blue wall surfaces are encouraged in vocational high schools with a majority of male students to improve the learning environment (Hettiarachchi & Nayanathara, 2017). Using cool colours can promote efficiency, trust, and communication compared to warm colours, and therefore, educators can utilise them to encourage students' creativity in the classroom (Jain, 2020; Llinares et al., 2021). Negatively interpreted colours may have a negative impact, which in turn lessens the avoidance of learning the material and lessens memory retention of the message. Red has a negative impact on creative performance. Contrarily, employing blue backdrops helps improve memory for information (Kumi et al., 2013; Zhu & Mehta, 2017). A study showed that warm-coloured classroom walls improve attention and performance compared to white or cold-coloured walls. Green walls were rated better for enjoyment and relaxation, whereas red walls were rated lowest for peace. Yellow walls dramatically impacted individuals' self-rated ability to pay attention (Liu et al., 2022);

- Factors influencing creativity. Individuals' mental state or mood can significantly impact their creativity. Many elements, including concentration, flexible shifts in attention, and relaxation, might impact this mental state (de Beuckelaer et al., 2007; Ding et al., 2014).

Overall, these studies suggest that using colour in interior design can significantly impact students' performance, behaviour, and satisfaction in design schools. Designers should consider the specific needs and goals of the space, as well as the cultural and psychological associations of different colours when selecting colour schemes for interior design. The research highlights a gap in previous studies concerning the interplay between creativity and cognitive processes influenced by colour in educational environments. Exploring how different colours can foster creative thinking and enhance cognitive functions presents a promising avenue for future research and practical application in design schools. By integrating these insights, designers can optimize learning environments to better support students' holistic development and educational outcomes.

The study highlights a gap in existing literature by focusing on the specific impact of different shades of classroom walls on student creativity within a design school. Past research has generally explored the broader effects of colour on learning environments, but this study delves deeper into the significant effects of specific colour combinations on creativity and performance through the following stages:

1. Using a virtual reality experiment. The use of virtual classrooms provided a controlled environment to isolate the impact of colour while minimizing other confounding factors;
2. Focusing on design schools. The study specifically targeted design students, whose creativity and performance are particularly relevant to the impact of the learning environment;
3. Detailed colour analysis. The use of the Munsell colour system to analyse colour hue, value, and chroma allowed for a more precise and nuanced understanding of colour effects;
4. Subjective surveys. Gathering student perceptions through surveys provided valuable insights into their experiences and reactions to different classroom colours.

By combining these methodologies, the study offers a more comprehensive and in-depth understanding of the relationship between classroom colour and student outcomes.

3. Methodology

To give the subjects immersive spatial experiences, virtual classrooms with various wall colours were built using virtual reality (Tables 2–3; Figure 2). After that, the subjects were asked to complete a *Google Forms* form with questions about their ability to concentrate, level of stress or anxiety, readiness to work, *etc.* Each of these subjects saw three colours, each having two different values and chroma, resulting in six different colours on the classroom walls:

- Participants. The experiment involved 36 participants: 69% women, 31% men, and a 20-year-old average age. All participants had to be in excellent health and free of major illnesses like severe colds, fevers, colour blindness, and other conditions at the time of recruitment. Additionally, individuals were not allowed to participate in the trial if they had dizziness, nausea, or an inability to adjust to the virtual reality environment;
- Colour selection. Colours are described by their hue, value, and chroma in the Munsell colour system. The value of a colour refers to its lightness or darkness, chroma to its saturation, vividness, or intensity, and hue to the predominant wavelength of the physical stimulus (Llinares et al., 2021). For example, the colour 5BG 5/10, means 5BG = hue (blue-green), 5 = value and 10 = chroma. Three colour hues with two different values and chroma have been selected for this study, which are green-yellow (114, 127, 82), green-yellow (105, 131, 130), blue-green (37, 150, 190), blue-green (48, 132, 154), red (196, 88, 88), and red (231, 49, 69);

Table 2. The colours selected for the virtual reality experiment (source: created by authors)

SL.NO	MUNSELL NOTION	COLOUR	RBG COLOUR	SWATCH
1	5 GY 5/4	Green yellow	114,127,82	
2	5GY 5/10	Green yellow	105,131,130	
3	5BG 5/4	Blue-green	37, 150, 190	
4	5BG 5/10	Blue-green	48,132,154	
5	5R 5/10	Red	196,88,88	
6	5R 5/16	Red	231,49,69	

Creating the virtual world. Using *Twinmotion* and *SketchUp* 2021, a computer model based on a typical design classroom was created and rendered. Its dimensions were 13100 mm by 7200 mm by 3800 mm. The experimental schematic diagram is displayed in Figure 2. The virtual classroom was shown on virtual reality glasses that the students were wearing.

Table 3. The specification of the virtual reality headset (source: created by authors)

Usage	Test	Program parameter	
Head-mounted display	Virtual reality scene build	Resolution 1080 × 1200 per eye	View 110°

Figure 2. The prototype model used for performing the virtual reality experiment (source: created by authors)

3.1. Experimental procedure

The experiment took place in the same laboratory over the same time frame (Table 4). The laboratory's interior temperature was +23 °C. Figure 3 shows participants participating in the experiment. Each participant put on the headset and went through each of the six scenes for one minute before answering questions on a *Google Forms* form. Questions were asked based on the factors, which influence creativity.

Figure 3. Participants during the experiment (source: created by authors)

3.2. Experiment sequence

The sequence of the experience of the research is given below (Table 4).

Table 4. Time required per subject (source: created by authors)

Concept	Time (minutes)
Participation initiation: time for instructions and participants to adjust to the virtual reality setting	2
FOR 1 SETTING	
Exposure to virtual reality setting	1

End of Table 4

Concept	Time (minutes)
FOR 6 SETTING	
Exposure to virtual reality setting	6
After experiment	
Fill out the questionnaire	–
TOTAL	10

4. Study analysis

The individuals filled out a *Google Forms* form to examine how the colour of the classroom walls affected their creativity as college students. The analytic hierarchy process (AHP) has been used to analyse the collected data. AHP begins with establishing the intended outcome of the analysis before coming up with several alternatives and several criteria or even sub-criteria to compare them to. The AHP is most effective at reducing evaluator biases by giving intangible factors a numerical value through pairwise comparison of the criteria and alternatives. Since its creation, the AHP has served as a tool for decision-makers and researchers. It is one of the most used methods for making multiple-criteria decision analysis (Vaidya & Kumar, 2006). Here the parameters are positive or negative impact, boosted concentration, willingness to work, reduced stress, ease, and willingness to sit for longer. It has been quantified through pie charts and analysed in this chart.

5. Data analysis

Figure 4 displays the subjects' ratings of the positive influence, concentration, willingness to work hard, and stress reduction. Green-yellow (114, 127, 82) and blue-green (37, 150, 190) walls had a more favourable effect on the participants than green-yellow (105, 131, 130) and blue-green (48, 132, 154). The participants responded most favourably to blue-green (37, 150, 190), whereas negatively to red (231, 49, 69). Compared to the other chosen colours, the colour blue had a beneficial effect. Blue-green (37, 150, 190) and green-yellow (114, 127, 82) had the highest concentration ratings, followed by blue-green (48, 132, 154), green-yellow (105, 131, 130), red (196, 88, 88), and red (231, 49, 69). The highest concentration level was for blue-green (37, 150, 190) and the lowest for red (231, 49, 69). The classrooms with blue-green (37, 150, 190) walls ranked highly on the desire to work, followed by blue-green (48, 132, 154), green-yellow (114, 127, 82), green-yellow (105, 131, 130), red (196, 88, 88), and red (231, 49, 69). The participants said they would be able to focus and more willing to work if only the main feature wall with the blackboard and projector was painted blue-green (48, 132, 154) and green-yellow (105,131,130). When compared to green and red, blue was preferred because it helped relieve stress. The most effective classrooms for reducing stress were those with blue-green walls (37, 150, 190), followed by blue-green (48, 132, 154), green-yellow (114, 127, 82), green-yellow (105, 131, 130), red (196, 88, 88), and red (231, 49, 69). The best rankings for visual comfort or ease in the environment were given to the classrooms with blue-green walls (37, 150, 190), followed by green-yellow (114, 127, 82), red (196, 88,

88), blue-green (48, 132, 154), green-yellow (105, 131, 130), and red (231, 49, 69). The walls coloured blue-green (37, 150, 190) had the highest ratings for willingness to sit for a longer time in the classroom, followed by green-yellow (114, 127, 82), green-yellow (105, 131, 130), blue-green (48, 132, 154), red (196, 88, 88), and red (231, 49, 69).

Figure 5 shows how the dull and intense colour impacts the participants. While the pale colours had a favourable impact, the vivid colours had a negative impact. Most participants chose blue over green and red. Most participants preferred it if light-emitting diode screens were installed or if the colour of the wall changed frequently (Figure 6).

6. Findings

This study explored the subjective ratings through *Google Forms* by doing a virtual reality experiment in +23 °C indoor air temperature. It carefully examined the effects of classroom environments with differing wall colours on student performance and creativity. The results are summarised as follows (Figure 4):

- Blue-green (37, 150, 190) and green-yellow (114, 127, 82) were the most positively perceived colours, associated with increased focus, concentration, and reduced stress;
- Green-yellow (105, 131, 130) and blue-green (48, 132, 154) demonstrated moderate positive effects and are suitable for the main feature wall of a classroom;
- Red walls (196, 88, 88; 231, 49, 69) had a negative impact and should be avoided in educational settings;
- Zonal differentiation can be achieved by using different colours in various areas of a classroom, such as discussion, working, and presentation zones;
- Individual learning areas can benefit from distinct wall colours. For example, design studios might benefit from blue-green and green-yellow, while activity areas could use green and yellow;
- Digital walls may be preferred by students over traditional painted walls, suggesting the potential of incorporating digital screens into classroom design.

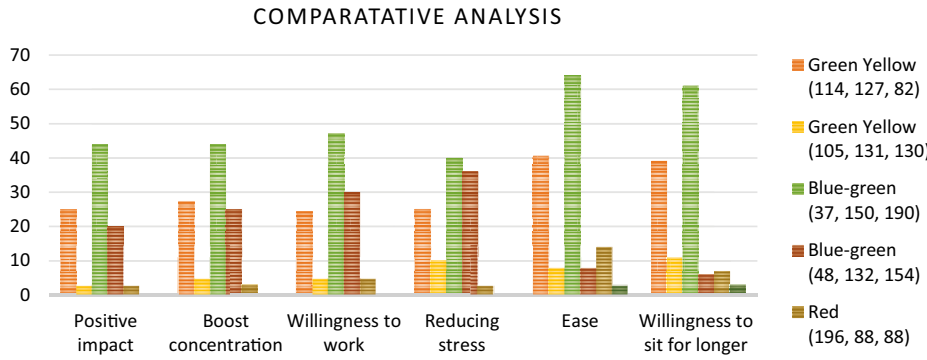

Figure 4. Comparative analysis (source: created by authors)

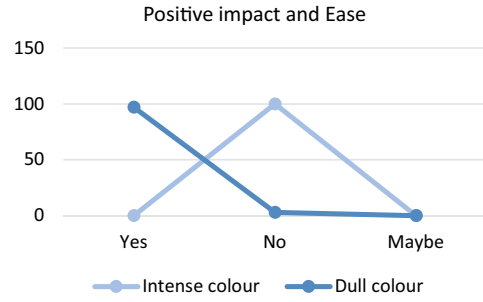

Figure 5. Dull and intense colour impact on the participants (source: created by authors)

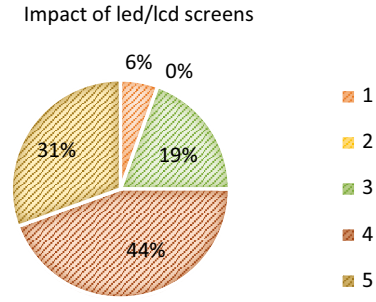

Figure 6. The impact of light-emitting diode screens (source: created by authors)

7. Discussion

Designing interiors to enhance creativity is a complex and multifaceted endeavour, particularly within educational environments where the goal is to foster creativity in students. Among the various factors that contribute to the efficacy of such spaces, colour plays a pivotal role. In the context of an interior design school, where the cultivation of creativity is paramount, the strategic use of colour becomes even more critical. The following design strategies, grounded in empirical research, offer a framework for leveraging colour to create an environment conducive to creativity:

- Colour selection based on positive influence and concentration. Use blue-green (37, 150, 190) and green-yellow (114, 127, 82) for classroom walls to enhance positive influence, concentration, willingness to work hard, and stress reduction;
- Effectiveness of specific colours on creativity. Use green yellow (105, 131, 130) and blue-green (48, 132, 154) for feature walls like those with whiteboards or blackboards. These colours can foster creativity without causing distraction, focusing students' attention effectively;
- Avoidance of colours with negative effects. Avoid red (196, 88, 88) and similar shades in educational settings as they have shown to negatively impact participants;
- Zone-specific colour application. Implement colour zoning in classrooms where different areas (discussion, working, presentation) can benefit from distinct colours like blue-green (37, 150, 190) or green-yellow (114, 127, 82) depending on the activity;
- Diverse colour use in different learning areas. Design studios and areas requiring creativity should feature blue-green (37, 150, 190) and green-yellow (114, 127, 82). Activity areas like workshops can utilize green-yellow (105, 131, 130) and blue-green (48, 132, 154) to maintain engagement and creativity;
- Preference for digital walls. Consider integrating digital screens in classrooms to allow for dynamic colour changes, catering to varied activities and enhancing student engagement and creativity.

8. Conclusion

Colour is vital in interior design, especially in a design school. Colours can evoke emotions and create a particular atmosphere in a room, affecting students' moods and creativity. The study findings underscore the significance of colour in interior design, particularly within educational settings like design schools. Colour psychology research consistently demonstrates the ability of colours to evoke emotions, create specific atmospheres, and influence mood. Beyond their emotional impact, colours can also be used strategically to highlight focal points, enhance visual interest, and promote engagement.

For design schools, incorporating a diverse colour palette is crucial for creating a stimulating and inspiring environment. By understanding the psychological associations of different colours, designers can select hues that promote creativity, relaxation, or focus, tailoring the environment to specific learning objectives. Additionally, balancing colours within a space ensures a visually harmonious and engaging atmosphere.

In conclusion, effective use of colour in interior design can significantly enhance the learning experience for design students. By considering colour psychology, creating a balanced colour scheme, and strategically highlighting focal points, designers can create spaces that inspire creativity, promote focus, and ultimately contribute to the success of design education.

While the study effectively controlled the abovementioned variables, further research could explore how virtual reality technology may influence colour perception and, consequently, the study's outcomes. Some of the potential areas for future research could include:

- Virtual reality technology limitations. Investigate whether the virtual reality technology used in the study accurately replicated the visual experience of real-world colours;
- Individual differences. Explore how individual variations in colour perception, such as colour blindness or personal preferences, might affect responses to different colours in virtual reality;
- Comparison with real-world environments. Conduct a similar study in a real-world classroom setting to compare the findings and assess the extent to which virtual reality accurately simulates colour perception.

By addressing these factors, future research can provide a more comprehensive understanding of the relationship between classroom colour and student performance, strengthening the generalizability of the findings.

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