# The Effect of Colours Used in Secondary Schools on the Efficiency of Learning

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## Abstract

The educational environment includes many educational and architectural factors. The current study investigates the effect of colors on the efficiency and quality of the learning process. The physical environment should be a living and dynamic factor in the quality of students' education. The study aims to enhance and support the findings of previous relevant studies, which emphasized the effect of colors as a means of conveying meanings that affect students' behavior and understanding. The study used the quantitative survey method and questionnaire as a means of collecting information in secondary schools, with 175 male and 175 female students. A questionnaire was made for nine colors, six monochromatic colors Yellow, Orange (Yellow orang), Green, Blue, White, and Grey, and three colors with complementary movement, Blue + Yellow, Greenish yellow + Blue, and Reddish yellow + Greenish blue. The results showed that cold colors with a complementary color, such as blue + yellow, green yellow + blue, and reddish yellow + green blue, are preferred and are the most used in the educational environment, followed by single cold colors such as green and blue, as these colors are considered comfortable and soothing to the eyes due to their short wavelength, which helps... Increasing focus and attention for longer periods without feeling bored, meaning that it is likely to be used in educational spaces because it positively affects the perception and understanding of recipients and can help create an ideal educational environment that combines focus and psychological and visual comfort. On the other hand, colors with high wavelengths (warm colors), such as red, and neutral colors, such as gray, are the colors of anxiety, fear, and boredom, and can create an atmosphere charged with tension, lack of concentration, and boredom in educational environments, which negatively affects students' performance.

**Keywords:** Colour, Architecture, Education, secondary school, efficient learning

# 1. Introduction

There are color-related myths and associations in every civilization. The fourth-century B.C. Aristotle identified blue and yellow as primary hues and associated them with fundamental human polarities like sun-moon and woman-man. In addition, he made a connection between colors and the earth, fire, water, and air components. Following their acceptance, Aristotle's ideas were applied for two millennia until Newton's discoveries in the 17th and 18th centuries led to the development of the general color theory, which eventually superseded them [1,2].

Isaac Newton published his first color research in 1672. Forty years later, despite intense dispute at the time, it became the cornerstone of optics. Newton was able to discern between the many color components in the spectrum by using a triangular prism to filter white light. This allowed him to see how the light wavelengths broke at various angles. Additionally, Newton created the first color wheel [2,3].

In 1969, Brent Berlin and Paul Kay introduced a theory of cross-cultural color conceptions predicated on a basic color term1 [4]. Berlin and Kay presented a sequence that predicts the meaning of basic color terms (BCTs) based on the quantity of BCTs in a language. A Stage I language will have names for black and white, according to the system. These are connected by a term for red in Stage II. Either a word for green appears first in Stages III and IV, or a word for yellow appears first, and then a word for yellow. In Stage V, a word for blue appears, and in Stage VI, a term for brown appears. Words for pink, purple, orange, and gray then occur in Stage VII, though not in any particular order [4]. Modern cultures have hundreds of color words in their languages. Color affects people's emotions, behavior, and even psychological health, whether or not they are aware of it [5]. youngsters are sensitive to color and also associate color with emotion; joyful feelings are linked to bright colors in youngsters, while bad emotions are linked to dark hues [6]. Given this, the color could act as a cue for kindergarteners, especially in the classroom. The environment of the classroom may have an effect on preschoolers' behavior, helping them to focus and calm down.

Colorful designs are used when the target audience is youngsters since color has the power to convey a variety of emotions and even alter people's moods, particularly in children. Youngsters are color sensitive and correlate emotion with color; bright colors are associated with happy feelings, whereas dark colors are associated with negative emotions [7] (Jonauskaite et al. 2019). As a result, preschoolers in kindergarten may use the hue as a cue, particularly in the classroom. Preschoolers may be impacted by the classroom environment if it helps them to control their emotions so they can focus on learning. The purpose of the study is to ascertain how colors affect students' performance in academic

settings. In this study, the link between the dependent variable—the students' perception—and the independent variable—the nine chosen colors—is examined.

**Color Wheel**

The fact that colors on the color wheel are approximately separated into warm and cool hues is another significant characteristic that may be utilized to set the atmosphere of a space. Red, orange, and yellow are warm colors, whereas blue, green, and purple are cold hues. Cool colors connect calmness, harmony, and tranquility, whereas warm colors generate sentiments of activity, passion, and even rage [8].

There are many color systems, according to the Munsell System, any potential color perception may be characterized by three factors: chroma, value, and hue (the name of the color, such as red, blue, or green) (purity, or difference from neutral grey). A letter stands in for the hue, a number for the value, and a number for the chroma in the alpha-numerical labeling of every color. Even if the other two variables are different if two Munsell Color samples are equivalent to one variable, they will seem the same in that attribute. The Munsell System's [9] new element was the independence of these variables.
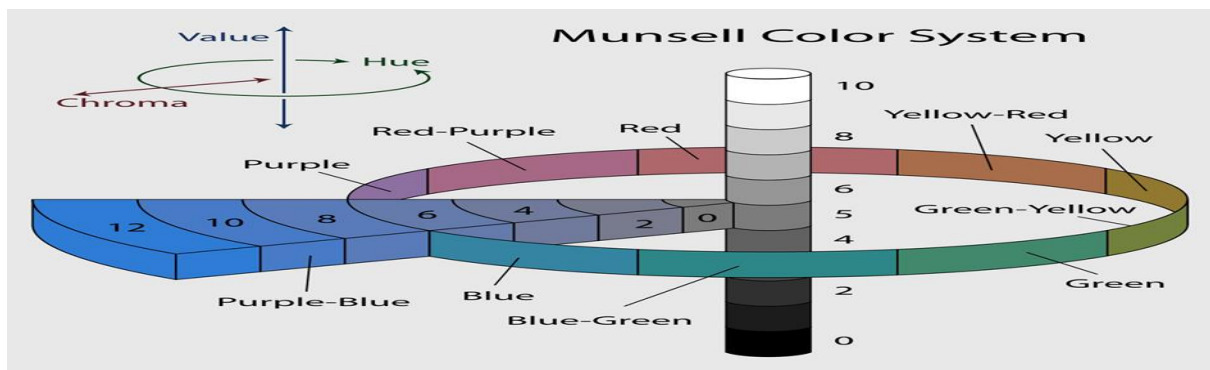


**Figure 1: Schematic diagram of the Munsell color system. From black to white, the value axis runs vertically; colors circle the vertical axis; and the chroma scale extends outward perpendicular to the value axis. 2007 Jacob Rus image.**

The Munsell Color Order System uses a three-dimensional model to properly define colors and display how they relate to one another. Hue, Value, and Chroma are the three characteristics of any color.

A Munsell Notation is always written in a specific order as a fraction.

For example, 5R 5/5

5R=Red HUE at step 5

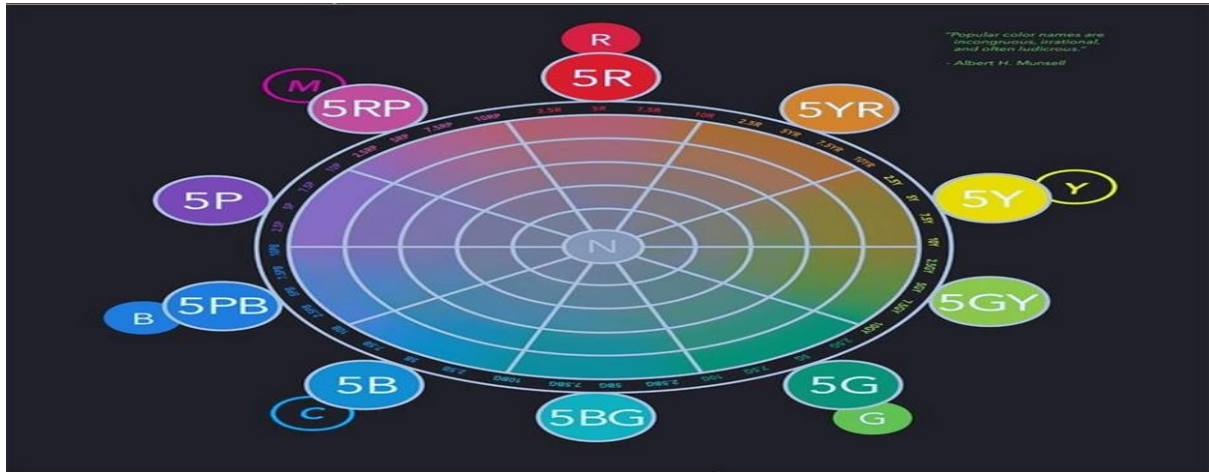5/=a VALUE step of 5

/5= a CHROMA step of 5



**Figure 2: Munsell hue circle**

**Color psychology**

The brain releases hormones in response to the color that has been conveyed by the eyes, and these hormones have an impact on our mood [5] . This is how psychological reactions to color occur. As a result, different colors used in a location can cause people to feel various emotions and moods [10].

[11]  Furthermore, color permeates every part of the human body, mind, soul, and emotion, according to Helvacolu (2011). It may be used to develop a setting that inspires the intended feelings and moods or to develop a particular appearance or style. Design decisions should take into account the physical and psychological properties that color conveys. The psychological, physiological, and social responses of people, as well as the aesthetic and technical features of surroundings that have been created by humans, are all directly related to color [12].

We can be affected differently by different colors since they have distinct wavelength frequencies. Red, for instance, symbolizes passion, love, and strength in terms of psychology [11].

The color yellow is associated with brightness, happiness, and vitality. It makes people feel warm and welcoming, and children enjoy it more than any other color [5]. But the color blue always conjures up images of quietness and serenity since it has a calming influence on those around it [11]. The influence

of color on the interior environment is significant. The color will be the first thing that people notice when they enter a location [13]. The wall in the room will serve as the most powerful stimulation for individuals in the interior space, aside from color and architectural features. The interior wall's color has a significant psychological influence on people [14]. To achieve desired goals, learning is a multidirectional process involving a variety of components, including teachers, students, and elements of the learning environment [15].

Creating spaces specifically for students involves creating the circumstances needed for their physical, mental, emotional, and social development at various ages, and this design shouldn't interfere with their ability to grow naturally or enjoy themselves. The physical environment of the school must play a vital and active role in the level of the student's educational and training activities in the current educational system. Based on understanding the aesthetics principles, while creating a physical environment, The use of environment, context, and color as perceptual principles is crucial. According to the researchers' results, colors have remarkable impacts on people's mental and morale. Depending on the color, people may feel happy, energetic, and moving or they may feel down, exhausted, or dull, and this may affect how well they do. [16].

According to research by [17] Engelbrecht and [18] Hathaway, the cerebral stimulation provided by the classroom's color helps teachers and pupils focus on their tasks. The red and blue color appears to be the main focus of many studies on this topic.[19] This intense attention might be caused by the fact that blue and red are made up of two of the three primary colors, and that blue has short waves while red has long waves [20]. Children are born with some potential skills, and the majority of these skills develop into active skills after being acquired. The majority of parents work to discover and develop their kids' talents. The importance of education, training, and teaching in shaping children's personalities cannot be overstated; one crucial area in school is in this respect. Several studies suggest that the physical environment plays a vital and dynamic role in the effectiveness of the teaching and training process. Architecture's quality, as well as other components like lighting, color, sound, systems, and other equipment, may be just as significant as other determinants of education and training factors. Being the defining feature of architecture, color has a significant impact on the behavior and morale of users. Moreover, light and colors might have an impact on children either visually or non-visually [21].

**Color and interior environment**

Color is considered one of the elements of interior design, as it greatly affects the atmosphere and general appearance of the space. Colors convey different feelings such as warmth, comfort, vitality, and activity, which determine the general mood of the place.

Emotions can be expressed through color. It is a manifestation of some extremely deep emotions from the human heart. The term "soul" for interior color refers to the limitless hue that can arouse feelings of the media. Its intrinsic force can elicit a direct and meaningful response. It is employed in architecture, and interior spaces are no different; it has a big impact on how shape and space are perceived. One of the most important and dynamic factors is the interior design, which holds a significant influence. The color palette works well for meeting aesthetic standards and allowing for individual expression among occupants [22].
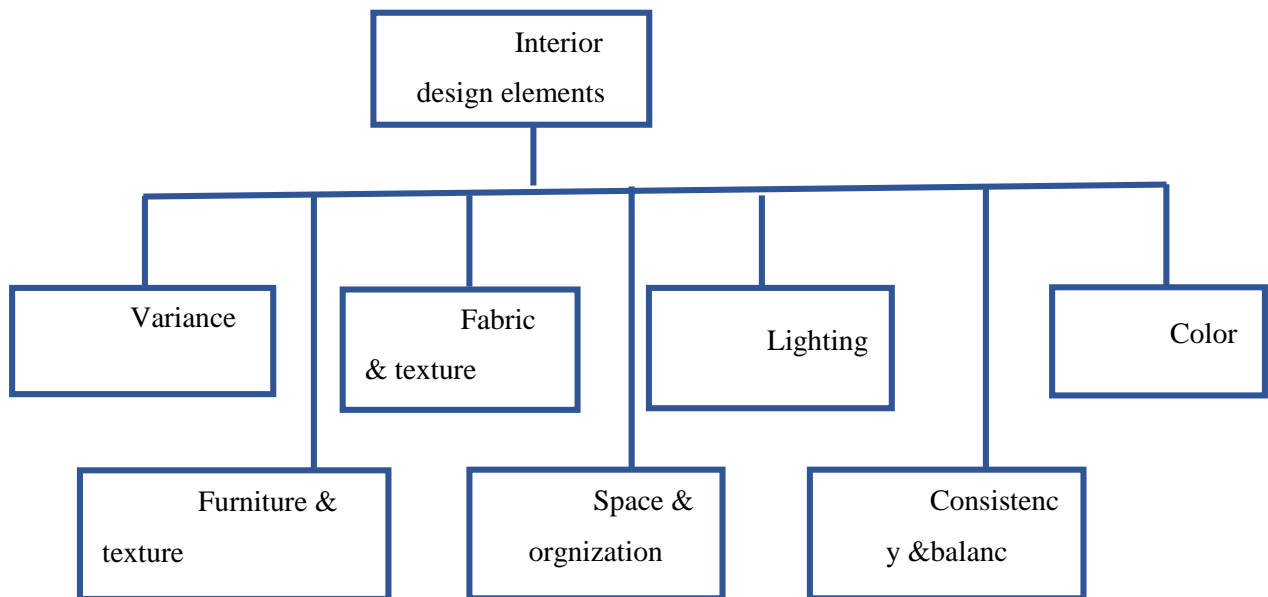


**Diagram 1: Interior design elements.**

A space's interior architecture is influenced by a multitude of elements. One of the fundamental components of interior design quality is color. Regarding the psychological effects of colors and the aesthetic comfort they offer, there are a lot of sophisticated ideas and presumptions. Research in this area demonstrates a variety of impacts on the use of color in interior public spaces. Its impacts on worker productivity and behavior, hospital patient recuperation, and school student task efficiency have all been demonstrated [23].

**Figure 3: By Monique Taylo, 2018.**

The individuals' physical symptoms and anxiety subscales related to mental health are significantly impacted by the interior design. The people who inhabit an environment are impacted by its interior design, and it is feasible to create environments that are appropriate given their surroundings and the effects they have on students [24].

Studies show that students who use blue do higher on IQ exams and find it easier to finish difficult assignments, Llinares, Higuera-Trujillo, and Serra 2021 [25]. Moreover, a condominium's interior design that incorporates cool colors encourages tranquility and relaxation, Ghashghaei *et al*. 2017 [26].

**Student's perception of school colors**

With the intention of connecting people's internal and external worlds through sensations, a large number of psychologists have focused on the study of perception [27]. Essential components of our visual sense are colors. Every time we open our eyes, we come into contact with and are surrounded by color, Meerwein, 1998 [28].  Even though color is only viewed by the eyes, all five of our senses are affected by it, therefore color is a tool that architects use to express themselves and capture the essence of what they wish to say, Bahamon, 2010 [29]. According to Tiina Rosenqvist's research, vision can be adapted to and processed by the brain for a wide range of color perception events. Essentially, vision serves to increase the manifestation of certain relevant talents [30]. Blue has been found to have a beneficial effect on students' attendance at school. As a result, it was discovered that colors can be used to create learning environments that support school learning objectives [31]. Children's cognition is significantly impacted by color, which implies that the detrimental effects of red on cognitive function—which have been shown in adults—also apply to young people. According to the research, color influences youngsters not just visually but also artistically and subtly affects how well they do on activities linked to their education. [32].

**Methodology**

**Subjects**

The participants were 350 students (175 students and 175 girls) in Al- Tahrir Secondary School for boys, Alhuria Secondary School for girls, Sulaymaniyah City, Iraq. The ages of the participants ranged between 13 and 15 years, and the average age was 14 years.

Table (1) indicates the difference in the Psychological effects of colors between boys and girls. In this study, 350 high school students participated, 175 boys and 175 girls. Students of the second class of secondary school were chosen to conduct the study.

**Table (1): Psychological effects of colors (impression and feeling, source: author).**

| The Colour | Student (boy) | Student (girls) |
|---|---|---|
| Yellow | Enthusiasm, activity | Activity, optimism |
| Orange | Fun, safety | Safety, emotional strength |
| Green | Harmony, comfort | Tranquility |
| Blue | Calm, thinking | Calm, communication |
| White | Peace, fineness | Sophistication and simplicity |
| Grey | Boredom, lack of energy | Boredom, gloom |

**A Colour Munsell**

Based on previous studies, it was observed that the use of monochromatic colors with a complementary color or movement has a significant positive effect, as it increases students' concentration and helps to attract attention and break routine and boredom. In this study, and based on the Munsell color system 6 colors were chosen: yellow, orange, green, blue, white, and grey, in addition to choosing complementary colors for comparison: Greenish yellow + Blue, Reddish yellow + greenish blue. A survey was conducted to find out the opinions of boys and girls students.

The Colour samples of the questionnaire sample were prepared using Photoshop for Munsell Colors available on PC software.

5R=Red HUE at step 5

5/=a VALUE step of 5

/5= a CHROMA step of 5

**Table (2): Munsell color notation.**

| Color | Hue | Value/Chroma |
|---|---|---|
| Yellow | 7.5Y | 8/10 |
| Orange(Yellow Orang) | 10YR | 5/10 |
| Green | 5G | 6/8 |
| Blue | 5B | 6/2 |
| White | N | - |
| Grey | N/6 | - |
| Blue + yellow | 5B 7.5Y | 6/2 8/10 |
| Greenish yellow + blue | 2.5 GY 5B | 6/10 6/2 |
| Reddishyellow+ greenish blue | 10YR 10BG | 5/10 8/2 |

Y=yellow, YR=Yellow Orange, G= green, B=Blue, N= Neutral, GY=Greenish Yellow, YR= Reddish Yellow, BG= Greenish Blue

**Procedure**

The survey was used as a method of data collection in Al- Tahrir Secondary School for boys, Alhuria Secondary School for girls, Sulaymaniyah City, Iraq in 2023. The questionnaire includes questions regarding the psychological effects of colors (impression and feeling) favorite and passionate color responses to each chosen color and how boys and girls feel about these colors. The survey was done using the Munsell color wheel.

**Statistical Analysis:**

The Statistical Analysis System- SAS (2018) program was used to detect the effect of different factors on study parameters. The chi-square test was used to significantly compare percentages

$$\chi^2 = \Sigma \; \frac{(O - E)^2}{E} \quad \text{……………………………………………………………………} \;\; ….(1)$$

$\chi^2$: Chi-square, $\Sigma$: Summation, O: Observed No., E: Expected No.

**Result and Discussion**

Table (3) shows the distribution of the sample of school students (boys) according to the favorite color of the classroom. The result shows that the highest ratio of monochromatic colors agree for green and blue was 5.71% while the lowest grey color was 1.14%.

The highest ratio of color selection with a complementary movement of colors Greenish yellow + blue was 12% while the lowest Reddish yellow+ greenish blue was 6.85%.

The highest ratio of selecting the monochromatic color to somewhat agree for the green was 4% while the lowest grey color was 1.14%.

The highest ratio of selecting the color with a complementary movement was blue + yellow 5.71% while the lowest Greenish yellow + blue was 2.85%.

The highest ratio of disagreement for the monochromatic color, orange was 4%, while the lowest green was 1.14%.

The highest ratio of disagreement of color with complementary movement of colors was blue + yellow at 3.42% while the lowest ratio of Reddish yellow+ greenish blue was 1.14%. There was a highly significant difference at (p= P≤0.05, P≤0.01) between the favorite color of the classroom.

**Table (3): The favorite color of the classroom (boys).**

| The colour | Agree<br>No. (%) | Somewhat agree<br>No. (%) | Disagree<br>No. (%) |
|---|---|---|---|
| Yellow | 6 (3.42%) | 5 (2.85%) | 5 (2.85%) |
| Orange | 4 (2.28%) | 5 (2.85%) | 7 (4%) |
| Green | 10 (5.71%) | 7 (4%) | 2 (1.14%) |
| Blue | 10 (5.71%) | 6 (3.42%) | 0 (%) |
| White | 8 (4.5%) | 5 (2.85%) | 4 (2.28%) |
| Grey | 2 (1.14%) | 2 (1.14%) | 4 (2.28%) |
| blue + yellow | 17 (9.71%) | 10 (5.71%) | 6 (3.42%) |
| Greenish yellow + blue | 21 (12%) | 5 (2.85%) | 3 (1.71%) |
| Reddish yellow+ greenish blue | 12 (6.85%) | 7 (4%) | 2 (1.14%) |
| Chi-square:$\chi^2$ | 9.73 ** | 4.88 * | 4.79 * |
| P-value | 0.0027 | 0.0376 | 0.0452 |
| * ($P \leq 0.05$), ** ($P \leq 0.01$). | | | |

Table (4) shows the distribution of the sample of school students (girls) according to the favorite color of the classroom. The result shows that the highest ratio of monochromatic colors for the green color was 7.42%, while the lowest gray was 1.71%.

The highest ratio of color selection with a complementary movement of colors, Greenish yellow + blue and Reddish yellow + Greenish blue was 12.57% while the lowest blue + yellow was 8.57%.

The highest ratio of selecting the monochromatic color to somewhat agree for the blue was 5.14% while the lowest yellow color was 1.14%.

The highest ratio of choice for the color with a complementary movement Greenish yellow + blue was 4.57% while the lowest Reddish yellow+ greenish blue was 2.28%.

The highest ratio of disagreement for the monochromatic grey color was 5.57%, while the lowest blue was 0.57%.

The highest ratio of disagreement of color with complementary movement of blue + yellow and Greenish yellow + blue colors was 1.14% while the lowest Reddish yellow+ greenish blue color was

0(%). There was a highly significant difference at (p= P≤0.05, P≤0.01) between the favorite color of the classroom.

**Table (4): The favorite color of the classroom (girls).**

| The colour | Agree No. (%) | Somewhat agree No. (%) | Disagree No. (%) |
|---|---|---|---|
| Yellow | 5 (2.85%) | 2 (1.14%) | 2 (1.14%) |
| Orange | 6 (3.42%) | 3 (1.71%) | 2 (1.14%) |
| Green | 13 (7.42%) | 5 (2.85%) | 4 (2.28%) |
| Blue | 9 (5.14%) | 9 (5.14%) | 1 (0.57%) |
| White | 12 (6.85%) | 7 (4%) | 2 (1.14%) |
| Grey | 3 (1.71%) | 2 (1.14%) | 8 (5.57%) |
| Blue + yellow | 15 (8.57%) | 5 (2.85%) | 2 (1.14%) |
| Greenish yellow + blue | 22 (12.57%) | 8 (4.57%) | 2 (1.14%) |
| Reddish yellow + greenish blue | 22 (12.57%) | 4 (2.28%) | 0 (%) |
| Chi-square:$\chi^2$ | 11.637 ** | 4.518 * | 4.601 * |
| P-value | 0.0019 | 0.0492 | 0.0478 |
| * (P≤0.05), ** (P≤0.01). | | | |

The results of Table (3,4) in the current study showed that monochromatic colors with another complementary color achieved the highest ratio first: greenish-yellow + blue, blue for walls and greenish yellow for chalkboard wall, with Hue, value, and chroma as mentioned in Table (2) where the ratio was (12%) for males and (12.57%) for girls, while the reddish-yellow + greenish-blue color was second, the greenish-blue color for the walls and the reddish-yellow for the chalkboard wall in terms of Hue, value, and chroma as mentioned in Table (2), and the percentage was (6.85%) for males and ( 12.57%) for girls.

The results showed that the blue + yellow color is the third choice, the yellow color for the walls and the blue color for the chalkboard wall, with hue, value, and chroma as mentioned in Table (2) were (9.71%) for boys and (8.57%) for girls.

As for the cold monochromatic colors such as blue and green, they came in second place, the blue color was (5.71%) of boys and (5.14%) of girls, while the green color was (5.71%) of boys and (7.42%) of girls.

Monochromatic warm colors such as yellow and orange came in third place, yellow was (3.42%) for boys and (2.85%) for males. While the orange color was (2.28%) for boys and (3.42%) for girls.

White neutral colors were (4.5%) for boys and (6.85%) for girls, while gray was (1.14%) for boys and (1.71%) for girls.

The results were found to agree with other results presented in different studies, a according to the previous study, blue and green are the best colors for fostering quiet and tranquility, and cool tones in the classroom improve memory and focus in students. [25]. Warm tones encourage pupils to be active, whereas blue encourages students to complete difficult work and score higher on intelligence tests [33]. However, to make the room more for students, the spaces must be supplemented with some bright, warm colors, like yellow or orange [33].

On the other hand, the study by Thung and Ahmad investigates that Green and blue are the colors that work well to create a learning environment in a classroom. This color can aid in relaxing and calming down students who are energetic and attentive throughout class lessons. The wall, floor, and classroom furniture may all be painted with the chosen color. A tranquil and pleasant environment may also be created in the classroom by introducing natural materials. yellow, red, and orange are warm colors that help stimulate children's activity. To make the classroom more exciting, the warm tones might be paired with the blue and green colors that are used there. Light blue and light green, bright colors, are good for the classroom while dark blue and dark green are not ideal because they will make students feel down [34].

[35] Kumi ., *et al* reported that there are four basic psychological colors (red, blue, green, and yellow).Green has a relaxing impact; it represents nature, serenity, and harmony and has a calming influence. Because green is the color of nature, many associate it with relaxation. Designers may employ paint to provide additional green to interior spaces to help people adjust to new situations [36]. Blue is suggested to be utilized in schools or study environments since it is regarded to be an intellectual and

logical thinking stimulant that stimulates clear cognition and enhances concentration. Since it makes us think of the sky and sea, it is a peaceful color [37].

According to the study of [38] Hidayetoglu, warm hues were more beautiful than other colors and had a better potential to be recalled. while the study by Yildirim., et al., [39], male students viewed blue classrooms more favorably than those that were cream or pink.

According to earlier research [40] ALAyash., et al. conducted on secondary school students' perception of colors, bright colors like blue, white, and yellow, etc., promoted good feelings in the students, such as happiness, hope, and joy.

According to the literature review, red and orange are the colors that may energize people and encourage engagement, while blue and green are thought to be the most calming colors overall. The usage of such hues in interior design can boost students' involvement [11].

**Conclusion**

The results showed that cool colors with a complementary color such as blue + yellow, green yellow + blue, and reddish yellow + green blue are preferred and are the most used in the educational environment, followed by single cold colors such as green and blue, as these colors are considered comfortable to the eyes and soothing due to their short wavelength, which helps Increasing concentration and attention. For example, blue in particular is considered a color that contributes to enhancing a feeling of calm and stability, which helps students to continue studying. It can also enhance creativity and positive thinking, which helps students develop new ideas and innovative solutions. Likewise, green is a color that is soothing to the eyes and contributes to reducing stress. And visual stress. Green nature makes people feel comfortable and can therefore contribute to creating a comfortable educational environment. That is, it is likely to be used in educational spaces because it positively affects the perception and understanding of recipients and can help create an ideal educational environment that combines focus and psychological and visual comfort. On the other hand, colors with high wavelengths (warm colors), such as red, and neutral colors, such as grey, are the colors of anxiety, tension, and boredom and can be very stimulating to the nervous system, causing increased levels of tension and stress in students. The color red in particular can raise blood pressure and increase anxiety, making the educational environment less calm and more stressful. Warm colors also tend to be eye-catching, which distracts students from academic tasks and also makes it difficult for students to concentrate for long periods. Although warm colors may be stimulating and exciting, they can cause feelings of anxiety or discomfort if in excess and may lead to overstimulation, making students feel tired more quickly, leading to a decrease in stamina

and concentration on educational activities. over a long period. That is, warm colors may be stimulating and exciting in some contexts, but in educational environments they may create an atmosphere charged with tension, lack of concentration, and stress, which hinders the educational process and negatively affects students' performance.

**References**

[1] Hunjet, A.; Pouzdanost R.A.L.(2002). sustava uređenosti boja, Psihologija boja, Magistarski rad, Tekstilnotehnološki fakultet Sveučilišta u Zagrebu.

[2] Hunjet, A. (2006). Utjecaj okoline na doživljaj boje, doktorska disertacija, Sveučilište u Zagrebu Tekstilno-tehnološki fakultet, Zagreb.

[3] Parac-Osterman, Đ. (2007). Osnove o boji i sustavi vrjednovanja. Tekstilno-tehnološki fakultet Sveučilišta u Zagrebu, Grafički zavod Hrvatske, d.o.o., Zagreb, ISBN 978-953-7105-11-2.

[4]. Berlin, B. and Kay, P. (1969). Basic Color Terms. University of California Press, Berkeley

[5] Vakili, H.; Niakan, M. H. and Najafi, N. (2019). 'The Effect of Classroom Red Walls on the Students' Aggression'. International Journal of School Health In Press (In Press). https://doi.org/10.5812/intjsh.86207.

[6] Cartwright, B. (2018). Your Guide to Colors: Color Theory, The Color Wheel, and How to Choose a Color Scheme. Retrieved from https://blog.hubspot.com/marketing/colortheory-desig

[7] Jonauskaite, D.; Dael, N.; Chèvre, L.; Althaus, B.; Tremea, A.; Charalambides, L. and Mohr, C. (2019). Pink for girls, red for boys, and blue for both genders. Colour preferences in children and adults, Sex Roles, http://dx.doi.org/10.1007/s11199-018- 0955-z

[8] Jonauskaite, D.; Althaus, B.; Dael, N.; Dan-Glauser, E.; Mohr, C. (2018). Color Res Appl., 1–13.

[9] Cochrane, S. (2014). The Munsell Color System: A scientific compromise from the world of art. Studies in History and Philosophy of Science, 47: 26-41

[10] Sebastian, D. (2020). 'Colour Psychology in Retirement Homes'. Victoria University of Wellington Wellington School of Architecture. https://researcharchive.vuw.ac.nz/xmlui/bitstr

[11] Helvacıoğlu, E. (2011). Colour emotion assosiation in interior spaces. Doctoral dissertation, Bilkent University.

[12] Tofle, R. B.; Schwarz, B.; Yoon, S.-Y. and Max-Royale, A. (2003). colour in health care environments. 220 Pacific Avenue, 6B San Francisco, CA 94115: The Coalition for Health Environments Research (CHER).

[13] Meyerhoff, Viviane Lee. (2016). 'The Effect of Visual Art Design on Mood, Creativity and Stereotypical Differences in Gender'. University of Twente. https://essay.utwente.nl/69979/1/

[14] Ghashghaei, A.; Hussien, H.; Ghaffarianhosein, A. and Ghaffarianhoseini, A. (2017). 'An Experimental. Comparison of the Effectiveness of Cool Colors as Environmental Stimulus on the Elderlies in Highrise Condominiums of Kuala Lump, Journal of Design and Built Environment. 17 (1).

[15] Armaki, M. A. and Farhadnia, N. (2021). The Effect of Color on Learning Efficiency among Primary School Students in Noorabad Delfan, Iran . Int J Pediatr., 9 (7): No.91

[16] Ahmadi, N. and Tabaeian, S.M. (2017). The Role of Color in Improving the Educational Environment Quality. International Journal of Architecture and Urban Development, 7(2)

[17] Engelbrecht, K. (2003) "The Impact of Color on Learning", Chicago, IL: Perkins & Will.

[18] Hathaway, W. E. (1987) "Light, colour & air quality: important elements of the learning environment", Educ. Canada, 27 (3): pp. 35-44.

[19] Mehta, R. and Zhu, R. J. (2009) "Blue or red? Exploring the effect of color on cognitive task performances". Science, 323 (5918): 1226-1229.

[20] Xia, T.; Song, L.; Wang, T.T.; Tan, L. and Mo, L. (2016). "Exploring the effect of red and blue on cognitive task performances" . Front. Psychol., 7(784) doi: 10.3389/fpsyg.2016.00784

[21] Ahmadi, A. and Tabaeian, S. M. (2017). The Role of Color in Improving the Educational Environment Quality. International Journal of Architecture and Urban Development, 7(2): Spring.

[22] Zhu, K. (2016). The Application of Color Design in Living Space, 2nd International Conference on Education Technology, Management and Humanities Science (ETMHS 2016) The authors - Published by Atlantis Press

[23] Ćurčić, A. A.; Keković, A.; Ranđelović, D. and Momčilović-Petronijević, A. (2019). EFFECTS OF COLOR IN INTERIOR DESIGN, Contemporary achievements in civil engineering 2019. Subotica, SERBIA, PROCEEDINGS 7th INTERNATIONAL CONFERENCE
[24] Taheri, Z. (2019). Studying the Effect of Classroom Interior Design on the Happiness and Mental Health of the Female Adolescent Students. J Biochem Tech., Special Issue (2): 138-148 ISSN: 0974-2328 9

[25] Llinares, C.; Higuera-Trujillo, J.L. and Serra, J. (2021) Cold and warm coloured classrooms. Effects on students' Attention and memory measured through psychological and neurophysiological responses. Building and Environment, 196 (107726)

[26] Ghashghaei, A.; Hussien, H.; Ghaffarianhosein, A. and Ghaffarianhoseini, A. (2017). 'An Experimental. Comparison of the Effectiveness of Cool Colors as Environmental Stimulus on the Elderlies in Highrise Condominiums of Kuala Lump. Journal of Design and Built Environment, 17 (1).

[27] Hoppu, U.; Puputti, S.; Aisala, H.; Laaksonen, O. and Sandell, M. (2018). Individual Differences in the Perception of Color Solutions. Foods, 7(9):154. 30

[28] G. Meerwein, B. Rodeck, F. Mahnke. (1998) "Color communication in architectural space". Birkhauser Verlag AG, Basel, Switzerland31

[29] Alejandro, B. and Maria, A. (2010). "Light, Color, Sound: Sensory effects in contemporary architecture". W.W. Norton & Company, New York, London 32

[30]-Rosenqvist, T. Color and Competence: A New View of Color Perception. In Life and Mind: New Directions in the Philosophy of Biology and Cognitive Sciences. Springer International Publishing: Cham, Switzerland

[31] Hettiarachchi, A. A. and Nayanathara , A.S.(2017) The effect of classroom color on learning with reference to primary education; a case study in Sri Lanka, Conference: International Conference on Global Education and ELearning, Colombo, Sri Lanka.

[32] Brooker, A . and Franklin, A. (2016). The effect of color on children's cognitive performance. British Journal of Educational Psychology, 86(2):241-55

[33] Jeddi, L. K. (2016). 'The Analysis of Effect of Colour Psychology on Environmental Graphic in Children Ward at Medical Centres'. Psychology and Behavioral Sciences 5 (2): 51. https://doi.org/10.11648/j.pbs.20160502.12.

[34] Thung, C. X. and Ahmad, H. (2022). Colour psychology in kindergarten classroom. ARTEKS: Jurnal Teknik Arsitektur, 7 (1): pISSN 2541-0598; eISSN 2541-1217

[35] Kumi, R.; Conway, C. M.; Limayem, M. and Goyal, S. (2013). Research article learning in color: how color and affect influence learning outcomes. IEEE transactions on professional communication, 56 (1): 2-15.

[36] NAz, K. and Epps, H. (2004) Relationship between color and emotion: A study of college students. College Student J., 38(3): 396.

[37] Gatzia, D. E.; Einsporn, R. L. and Ramsier, R. (2017). Enhancing student understanding of color perception: a teaching activity on intersubjective color variations. The American Biology Teacher, 79(4), 321- 328

[38] Hidayetoglu, M. L.; Yildirim, K. and Cagatay, K. (2010) "The effects of training and spatial experience on the perception of the interior of buildings with a high level of complexity", Sci. Res. Essays, 5 (5), pp. 428-439.

[39] Yildirim, K.; Cagatay, K. and Ayalp, N. (2014) "Effect of wall colour on the perception of classrooms", Indoor Built Environ., 24 (5), pp. 607-6

40-AL-Ayash, A.; Kane, R. T.; Smith, D. and Green-Armytage, P. (2016). The influence of color on student emotion, heart rate, and performance in learning environments. Color Research & Application, 41(2): 196- 205.

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## تأثير الألوان المستخدمة في المدارس الثانوية على كفاءة التعلم

**الخلاصة**: تشتمل البيئة التعليمية على العديد من العوامل التعليمية والمعمارية. تبحث الدراسة الحالية في تأثير الألوان على كفاءة وجودة عملية التعلم. يجب أن تكون البيئة المادية عاملاً حيًا وديناميكيًا في جودة تعليم الطلاب. وتهدف الدراسة إلى تعزيز ودعم نتائج الدراسات السابقة ذات الصلة والتي أكدت على تأثير الألوان كوسيلة لنقل المعاني التي تؤثر على سلوك الطلاب وفهمهم. استخدمت الدراسة أسلوب المسح الكمي والاستبيان كوسيلة لجمع المعلومات في المدارس الثانوية، حيث بلغ عدد الطلاب فيها 175 طالباً و175 طالبة. تم عمل استبيان لتسعة ألوان، ستة ألوان أحادية اللون الأصفر، البرتقالي (الأصفر البرتقالي)، الأخضر، الأزرق، الأبيض، والرمادي، وثلاثة ألوان مع حركة تكميلية، أزرق + أصفر، أصفر مخضر + أزرق، وأصفر محمر + أزرق مخضر. أظهرت النتائج أن الألوان الباردة ذات اللون المكمل كالأزرق + الأصفر، والأصفر المخضر + الأزرق، والأصفر المحمر + الأزرق المخضر هي المفضلة وهي الاكثر استخداما في البيئة التعليمية تليها الألوان الباردة الاحادية مثل الأخضر والأزرق اذ تعتبر هذه الألوان مريحة للعين ومهدئة بسبب طولها الموجي القصير مما تساعد على زيادة التركيز والانتباه لفترات اطول دون الشعور بالملل أي أنه من المرجح أن يتم استخدامها في المساحات التعليمية لأنها تؤثر بشكل إيجابي على إدراك وفهم المتلقين ويمكن ان يساعد في خلق بيئة تعليمية مثالية تجمع بين التركيز والراحة النفسية والبصرية. وفي المقابل فإن الألوان ذات الاطوال الموجية العالية ( الالوان الدافئة) كالاحمر والمحايدة، مثل اللون الرمادي، هي ألوان القلق والخوف والملل وممكن ان تخلق جو مشحون بالتوتر وقلة التركيز والملل في البيئات التعليمية مما يؤثر سلبا على اداء الطلاب.

**الكلمات المفتاحية**: اللون، الهندسة المعمارية، التعليم، المدرسة الثانوية، التعلم الفعال.