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Article

The evaluation of the impact of computer classroom wall colors on students' perception in the context of color components

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ABSTRACT

The arrangement of a computer class is as important as a traditional classroom layout. In recent years, as in traditional classrooms, environmental features of these classrooms, such as size, form, color, light, texture, etc., have a direct impact on students' perception, class participation, motivation, and concentration. This study aims to explore how various hues, values, and saturations of wall colors, representing a key environmental feature of a computer classroom, affect students' spatial perception. Saturated, medium, dark, and light colors of red, blue-green, and purple hues, totaling twelve colors, were determined from the Munsell Color System for the wall colors of the classroom. The classroom was visualized using these selected wall colors and presented to the students. Subsequently, they were asked to evaluate the visualizations through a semantic differential scale comprising fifteen bipolar items. The results revealed that students perceived high-value and saturated colors across all hues positively, describing them as pleasant, warm, and cheerful. Medium colors were viewed negatively, characterized by descriptions such as 'lifeless, dull, incomprehensible, unpleasant, ugly.' Dark colors received positive assessments, described as "pleasant, beautiful, clean, and bright" but were also associated with negative descriptions like 'gloomy, boring, passive, and dark.' Additionally, similar perceptions emerged among saturated, medium, light, and dark colors of all hues. This outcome suggests that even when color hues differ, similar values and saturations can evoke similar perceptions in spatial color perception.

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INTRODUCTION

As much as users shape the environment around their own needs, the existing environment is also effective on people's behavior and perception (Sommer, 1969). It has been found in the studies that the physical features of the built environment, such as form, color, texture, and lighting, have many effects on people's attitudes (Read et al., 1999; Hidayetoğlu, 2010; Yıldırım et al., 2007; Altun & Zorlu, 2022; Müezzinoğlu et al., 2020). These physical features influence the behavior of space users, the quality of the functions they perform, and their affective responses, such as satisfaction or dissatisfaction with the

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space. Additionally, these features impact their perception of the space as narrow or wide, spacious or stifling, and the duration of their stay in the space. Therefore, the perceptual and affective effects of spatial design elements on the user should be well known and designed accordingly (Aydınlı, 1986; Altun & Zorlu, 2022).

The physical properties (size, form, texture, color, light) of the classrooms where people spend a significant portion of their lives can positively contribute to education by enhancing students' perceptual, physical, and cognitive development, as well as their motivation, learning performance, experience, exploration, research, critical thinking, creativity, questioning, and socialization (Müezzinoğlu et al., 2020; Altun & Zorlu, 2021). Gifford (2002) stated that students can learn better in a well-designed classroom, while their attention may be distracted in an inappropriate physical environment. Walden (2009) has emphasized that color scheme, lighting, climate, acoustics, smell, and furniture in a classroom are important from the point of view of students' sense of well-being. Studies show that well-designed learning spaces increase the learning motivation, capacity of memorization, and willingness to study of students, and socially contribute positively to friendship relations. Consequently, it is important to organize and design classrooms in a way that supports these activities.

Baker (1986) has discussed interior space properties in three sections as ambient factors (sound, temperature, smell, lighting), design factors (form, color, texture, layout), and social factors (user age, gender, education, perception level, etc.). The differentiation of the three main factors and sub-variables that make up these interior features also causes changes in the perception of the space and the reactions of the users to it. Space color, one of the design factors, is a broad topic that has physiological, psychological (affective), behavioral, and cognitive effects on space users and needs to be researched. Researchers have found that colors have specific behavioral associations and can affect the mental and emotional balance of users when used skillfully and dynamically in the designed environment (Camgöz et al., 2004). In this context, what kind of color design should be applied for which function and user in a space should be planned in line with the effect of the color of the space on the user. In space color research, the effects of various colors on users have been examined. Manav's (2007) study on living space color, blue was found to be cold and associated with calmness. In Kwallek et al.'s (1996) study, it was concluded that participants tend to make more mistakes in office spaces with high in value colors. The sudy by Yıldırım et al. (2012) and colleagues showed that warm colors such as red, yellow, and orange tend to make the space perceived smaller than it is. Similarly, Frieling (1979) has stated that painting all the walls with a warm color would narrow the space because the walls give an effect that unites, surrounds, and directs the space. On the other hand, some studies have found that cool colors such as blue and green and light colors cause the space to be perceived much more spacious and larger, while dark colors cause the space to be perceived smaller (Mahnke et al., 2007; Yıldırım, Hidayetoğlu et al.; 2011). To exemplify, if a low ceiling is painted with a light color, the space will appear higher, while a high ceiling can appear lower with a dark color (Oberfeld et al., 2010). In a study in which users' perceptions of office space color were evaluated using warm (orange), cool (blue), and neutral (gray) color schemes, the office with warm color schemes was generally perceived more positively than offices with neutral and cool colors (Ergün & Yıldırım, 2022). These studies show that it is possible to create the desired effect with the different use of color in a space, and that it is possible to create a difference in the perception of space only with color without changing the dimensions of the surfaces in the space.

In studies which examine the effect of educational space color on students, results have been tested on whether students do not adopt the classrooms they have lessons in and whether they are satisfied with being in these classrooms. In various studies that examine the effects of educational space colors on students, researchers have investigated whether students feel comfortable in the classrooms and whether they are satisfied with the learning environment (Akalın et al., 2009; Hidayetoğlu et al., 2012; Read, 2003; Stone & English, 1998). Engelbrecht and Hathaway stated that the passive mental stimulation provided by the color of the classroom can help students and teachers to focus on their tasks (Engelbrecht, 2003 and Hathaway, 1987). In a study conducted for kindergarten wall colors, users associated a high saturation red class with anger, while a class with low saturation and high value red (pink) class was associated with happiness. In contrast to saturated red, saturated blue was associated with happiness and was the most preferred classroom color (Dalirnaghadeh, 2016). In a study on the behavioral and cognitive effects of primary school classroom wall color, the results showed that in the red environment, students have difficulty focusing on lectures, and students' movements were more intense and disturbing. Conversely, in a blue environment, they exhibited calmer behavior than ever. Wang and Russ' study on computer classroom wall color preference showed that purple, blue, and bluish-purple colors were associated with gender, age, and personality traits, and cool colors were preferred more than warm colors (Wang & Russ, 2008). Liu et al's (2022) study to investigate the effect of classroom wall color on students' performance, five different visualized classroom wall colors (red, blue, yellow, green, and white) were shown to students via virtual reality, and their subjective evaluation was measured with a questionnaire, and their physiological responses were measured with electroencephalography (EEG) and electrocardiogram (ECG). The results showed that cool colors such as blue and green had the highest level of relaxation and satisfaction, warm-colored walls such as yellow and red had better attention and learning performance, while the white-colored classroom had the lowest subjective evaluation and the worst learning performance (Liu et al., 2022). According to Müezzinoğlu et al.'s (2020) study on classroom wall color, neutral (gray) colored (achromatic) walls were perceptually evaluated more negatively than warm and cold-colored (chromatic) walls by students. Similar results were observed in another study for classroom wall color; white and gray classroom walls were evaluated more negatively than chromatic (red, blue, green, etc.) classroom walls. In a study carried out in primary school classrooms for color, it was concluded that students were not satisfied with the monotonous colors used in their current classrooms and desired colorful surfaces on walls and furniture (Altun & Zorlu, 2022). In another study conducted for wall colors in educational spaces, students found both warm and cool colors more positive than neutral colors (Müezzinoğlu et al., 2020). The results of these studies mentioned above show that users prefer chromatic (colored/non-neutral) colors rather than neutral colors on surfaces.

Trent emphasizes that when determining the colors to be applied in educational buildings and classrooms, the function of the space and the age group of the students should be taken into consideration. In classrooms, warm and saturated colors may be appropriate for younger users, while higher value colors may be appropriate for older ages (Trent, 1995; Faulkner, 1972; Barker, 1982; Altun & Zorlu, 2021). In this context, the age of the students also comes forward as an important parameter in classroom color perception.

In the studies where the effect of space color is considered in the educational dimension, environmental colors that will contribute to students' adoption of the classrooms where they study, their positive affective effects, learning, and concentration have been investigated with various methods (Akalın et al., 2009; Hidayetoğlu et al., 2012; Read, 2003; Stone & English, 1998). Herewith, based on the assumption that different wall colors affect the students differently, the research was designed to evaluate the effects of wall colors of a computer classroom in a Furniture and Interior Design technical high school on the perceptions of the students. The classroom was visualized in a computer, and four sub-colors with different values and saturation of three different color hues (totally twelve colors), selected from the Munsell Color system, were applied to the classroom walls. Since it is not possible to evaluate all the variables that make up the physical properties of the space, only the wall color variable was evaluated and, in the visualizations, only the wall color was emphasized by keeping other confusing variables (colors of furniture, texture, etc.) constant. Each visualized classroom picture with different colors was shown to the students, and they were asked to evaluate it through the semantic differentiation scale. Before delving into the research method, it is essential to clarify the issues related to color and color perception in space. This clarification will enable a better evaluation of the study findings.

COLOR PERCEPTION AND COLOR IN SPACE

Color is a highly influential design element that facilitates in comprehending, distinguishing, and defining the environment. To perceive, define, or use color effectively, it is necessary to understand its various properties. Color is the visual manifestation of the portion of the electromagnetic spectrum known as the visible light gap. Each color corresponds to a specific range of wavelengths within the visible light spectrum.

Visible light runs from a wavelength of about 380 nanometers (nm) at the violet end of the spectrum to around 760 nm at the red end of the spectrum. The human vision organ receives the light from a reflected source, processes it, and color is perceived (Figure 1).

The perception of elements such as color, texture, and form in the environment is realized through visual perception. Color perception is a part of visual perception, and humans determine and perceive the color of objects/surfaces according to the color of the reflected light. Color is an integral part of light and is a subjective sensation caused by physically measurable light. For example, a red surface appears red because it reflects red light more than other light incoming on it. Virtually, color is not an inherent trait of a surface or an object but rather it is perceived depending on the quality of light illuminating the object (Ural, 1995). Therefore, as the color characteristic of the light reflected

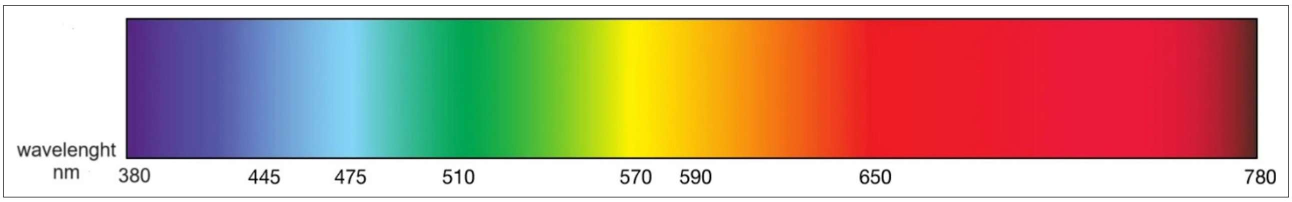


Figure 1. Spectrum of visible radiation.

from the surface changes, the perceived color of the surface also changes. Color perception, as in visual perception, depends on three necessary elements:

- properties of the light source,
- properties of the surface/object,
- the human organ of vision (eye).

As these variables change, color perceiving changes. The human organ of vision can distinguish approximately 2,500,000 colors (Pointer & Attidrige, 1998; Linhares et al., 2008). In this context, it is possible to create numerous distinct color impressions by changing the properties of the light illuminating the surface.

In scientific terms, colors are considered in two aspects: light colors and surface colors. Both light and surface colors have color properties defined by three components known as hue, value, and saturation, which can vary independently of each other. Hue distinguishes one color from another and is described by names such as red, blue, yellow, and purple. Value identifies the lightness and darkness of a color, while saturation expresses the purity of a color; the purer a color, the more saturated it is. With these three properties and different numerical definitions, colors can be expressed through various color systems. Colors are defined by color sorting systems, where similar colors are arranged next to each other, and perceptual steps are sequenced consecutively. Colors, specified in a particular order, are matched with coordinates in space and transformed into a three-dimensional 'color solid' system. Figure 2 illustrates the Munsell Color System, one of these systems.

The Munsell Color System, which is a surface color system, has been developed based on decimal notation with equal perceptual steps. As in other color systems, the Munsell Color System defines colors based on three properties of color: hue, value (lightness), and saturation/chroma, and each hue is represented on a page with different values and chromas.

In color perception, the hue of a color is categorized as warm, cool, or neutral. Colors with shorter wavelengths are classified as 'cool' colors, encompassing purple with the shortest wavelength in the spectrum (360-400 nm), followed by blue (400-480 nm), and extending to green (520-565 nm). Conversely, colors with longer wavelengths are termed 'warm' colors, which include red (625-760 nm), orange (590-625 nm), and yellow (565-590 nm) (Yıldırım, Capanoglu et al.; 2011). Neutral colors, ranging from black to white, lack specific color and are also referred to as 'achromatic' colors. Studies on interior color preferences have predominantly shown a leaning towards colors with shorter wavelengths or cool colors among users. This preference trend suggests a general correlation between wavelength and emotional states in spatial perception (Valdez & Mehrabian, 1994).

The value component is represented on the vertical axis in the color system, with black at the lower end and white at the top. There are several divisions of gray, evenly distributed between black and white. An increase in the saturation of a color means that the color becomes more perceptually effective in terms of hue. Approaching the gray bar, on the other hand, neutralizes the color; in other words, the effect of color is reduced. This implies that the more pure/saturated colors are applied in a space, the greater its impact with respect to hue (Figure 2). According to Küller et al.'s (2009) study, it was found that the saturated red room activated the brain and accelerated the heart rate. However, this result may not be applicable to the high in value colors of red referred to as pink, which may have a completely different effect. In Al-Ayash, et al.'s (2016) study, participants were calmer and more relaxed in the high-value colors of the same hue (red, yellow, and blue), while

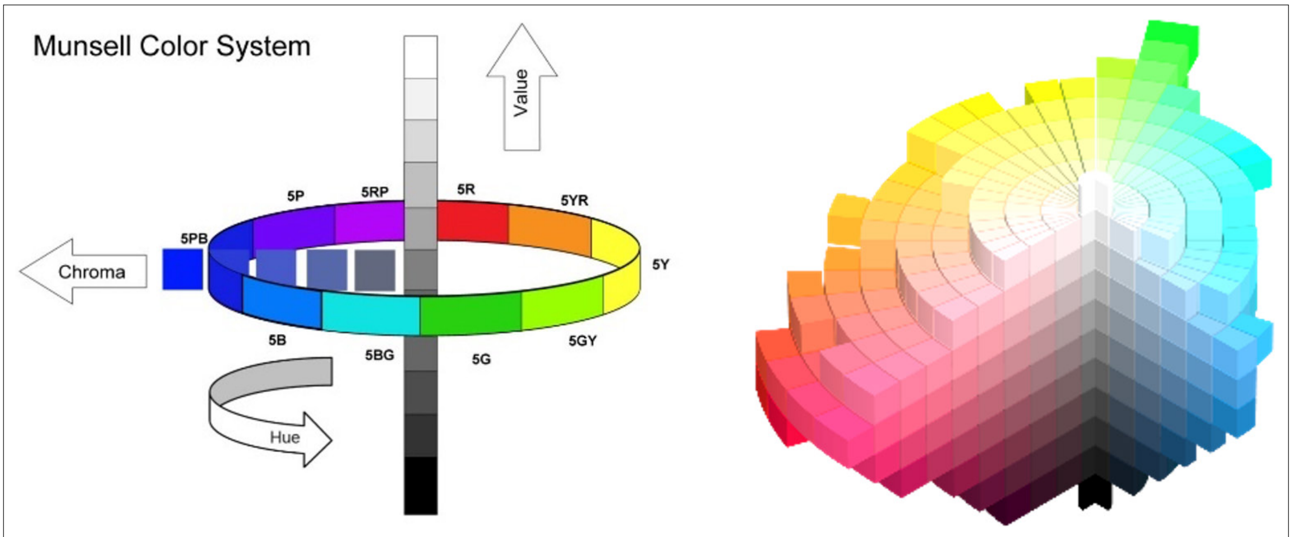


Figure 2. Munsell Color System (Sands, 2017; PNGINDIR, 2024).

their heart rate increased in high saturation. Elliot et al. (2007) have suggested that red impairs performance.

As can be inferred from the explanations provided, the perception of color and its application in a space is a complex topic. Studies on the effects of interior color have delved into various aspects such as the psychological and physiological impacts of colors, user preferences, the sensory and semantic evaluation of space color, and the productivity of the space based on its function. Aligned with these insights, this study explores the impact of color on perception and investigates how the color of classroom walls affects spatial perception.

MATERIALS AND METHODS

This study examined the perceptual effects of computer classroom wall colors on students in a Furniture and Interior Design high school. In this investigation, three hues and four sub-colors of each hue with different values and saturations, 12 colors in total, were utilized. The stages of the study included:

- Determining the colors for the classroom walls
- Visualizing the computer classroom and applying twelve different colors to the walls
- Presenting visuals of the classroom with different wall colors to students
- Evaluating the visuals using the Semantic Differentiation (SD) scale

Participants

The research was conducted with the students of Ümraniye Atatürk Vocational Technical High School in Istanbul. A total of 52 students, comprising 24 (46.2%) girls and 28 (53.8%) boys between the ages of 15-19, randomly recruited from the students who had prior experience with the classroom, participated in the experiment. There were no instances of color vision deficiency among the participants.

Experimental Space

The visualized experiment space is a computer classroom containing 24 computers. It was designed using the SketchUp program, with twelve different colors applied to its walls. These colors consist of three hues, each having four different values and saturations (Figure 3).

Determination of Wall Colors of Computer Classroom

The red hue color family has been extensively used in numerous studies aimed at investigating the impact of color on spatial perception. This color, having the longest wavelength, possesses a stimulating and attention-grabbing effect as observed in previous research, thus rendering it suitable for this study. Within the Munsell Color System utilized in this study, the 7R hue within the red color family is considered a warm color. Another preferred hue is blue-green (7BG), positioned directly opposite the red color on the Munsell hue circle, while the third preferred hue is purple (7P), situated between these two colors (Figure 4).

In most experimental studies on color, only the color hue (such as red, blue, yellow) is considered, being deemed the most prominent characteristic of color. However, in a broader context, acknowledging that each color hue possesses value and saturation, these components also undoubtedly exert effects on the user (Elliot, 2015; Kareklas et al., 2014; Lee et al., 2013).

Hence, in this study, the three preferred hues were further categorized into four sub-colors: saturated, medium, light (with high value), and dark (less saturated and low in value). These variations were visualized by applying them to the walls of the computer classroom using the SketchUp program

Figure 3. Classroom Plan and model.

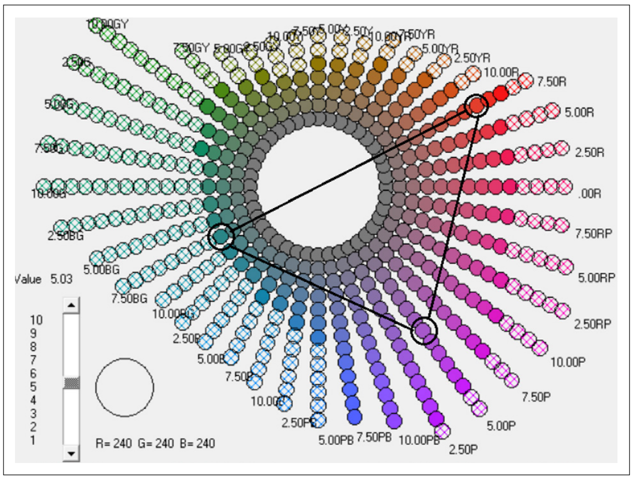


Figure 4. Munsell horizontal section view of red, blue-green and purple colors used in the experiment, Value:5 (WallkillColor, 2023).

(Figure 5a-c). The selected hue pages and sub-colors from the Munsell Color System are illustrated in Figure 6.

Questionnaire Design and Procedure

The questionnaire utilized for the evaluation of classroom wall colors is the Semantic Differential (SD) Scale, which was developed by Osgood, Suci, and Tannenbaum (1957) and has been previously employed in spatial assessment studies (Osgood et al., 1957; Yıldırım et al., 2011b; Imamoglu, 2000; Yıldırım et al., 2007). The questionnaire comprises two parts. The first part collects general information about the participants, including age and gender. The second part consists of the SD Scale, wherein students assessed twelve colors (three hues with varying values and saturations) applied to the computer classroom walls (Figure 7a-c).

The scale entails seven steps and fifteen pairs of adjectives used to evaluate the color characteristics of the classroom. A total of fifteen pairs are: beautiful/ugly, cold/hot, bright/dull, relaxing/incomprehensible, dynamic/static, active/passive, clean/dirty, concentrated/distracting, pleasant/unpleasant, exciting/boring, vivid/lifeless, dark/light. In compiling the list of bipolar items, the emphasis was on selecting adjectives that aptly describe color.

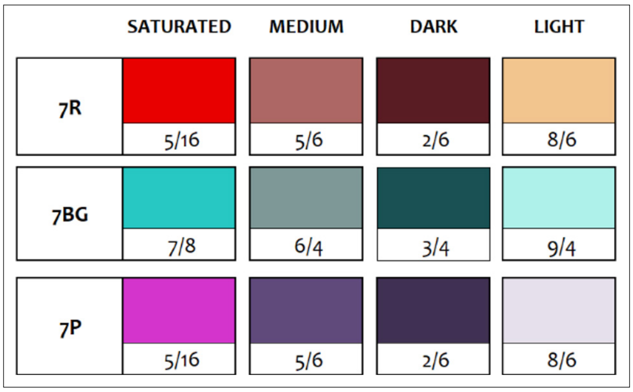


Figure 6. Munsell notations of classroom wall colors.

FINDINGS

The data from the Semantic Differential Scale (SD) were evaluated by the arithmetic mean method across all subjects, ignoring the gender difference. The arithmetic averages' results are given in Table 1, and the graphical outcomes according to the hues of red, blue-green, and purple are given in Figure 8 (7R red), Figure 9 (7BG blue-green), and Figure 10 (7P purple). Each bipolar adjective (items) was rated on a seven-point scale (from -3 to 3) established between the extremes. The "-" (minus) values in the table were evaluated as negative perception and the "+" values as positive. The closer values are to "-3" or "+3" for an adjective, the stronger the perception of the color described by that adjective as negative or positive.

As depicted in the graphics, results above the "0" (zero) line for each adjective pair are considered positive, whereas those below are regarded as negative evaluations. Mostly, all saturated colors were perceived as beautiful, warm, bright, and cheerful. However, this positive perception in saturated colors was reversed for "medium" colors of the

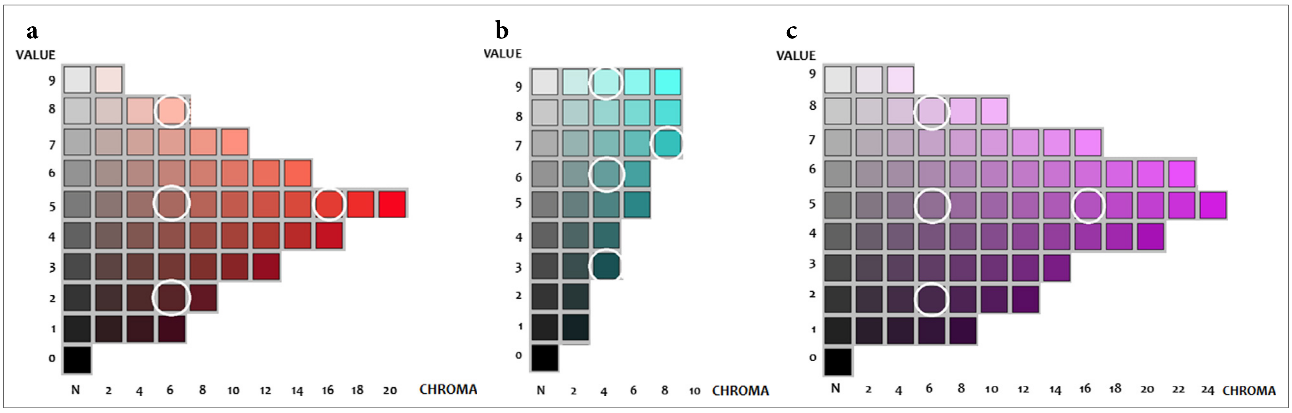


Figure 5. **(a)** Munsell 7R Red hue. **(b)** Munsell 7BG Blue-green hue. **(c)** Munsell 7P Purple hue.

Figure 7 (a). Visuals of the wall colors of red hue.

Figure 7 (b). Visuals of the wall colors of purple hue.

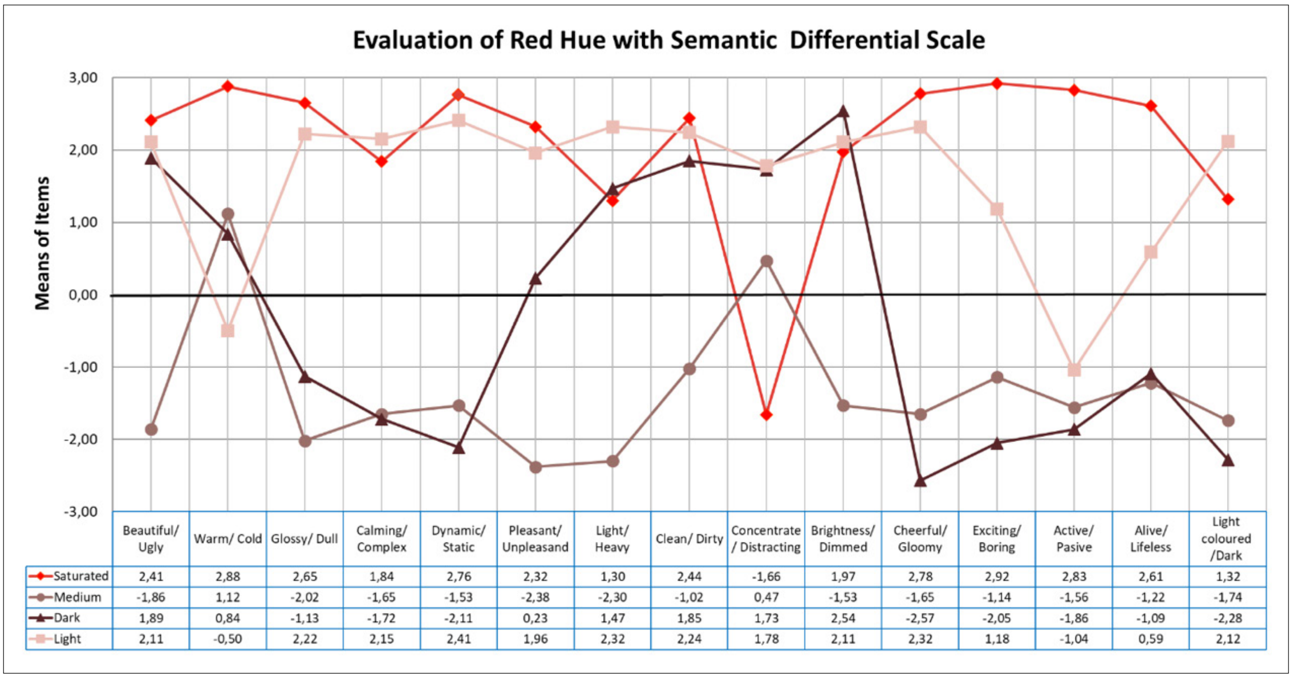
same hues, resulting in a negative impression. While the saturated red color was perceived positively in almost all adjective pairs, intriguingly, it was negatively evaluated as "distracting." This situation resembles findings in the literature, suggesting that red is considered a stimulating color and leads to a distracting effect (Al-Ayash, 2016; Küller et al., 2009). Another notable conclusion regarding saturated red is that students perceive it as highly

Figure 7 (c). Visuals of the wall colors of purple hue.

warm, dynamic, cheerful, and active. These findings are consistent with previous studies evaluating spaces with red color (Kaya & Epps, 2004; Nelson et al., 1984; Whitfield & Wiltshire, 1990; Küller et al., 2009; Nakshian, 1964). In a study centered on hue and saturation, it was deduced that users find saturated colors to be more attention-grabbing, like the outcomes observed in this study (Camgöz et al., 2004).

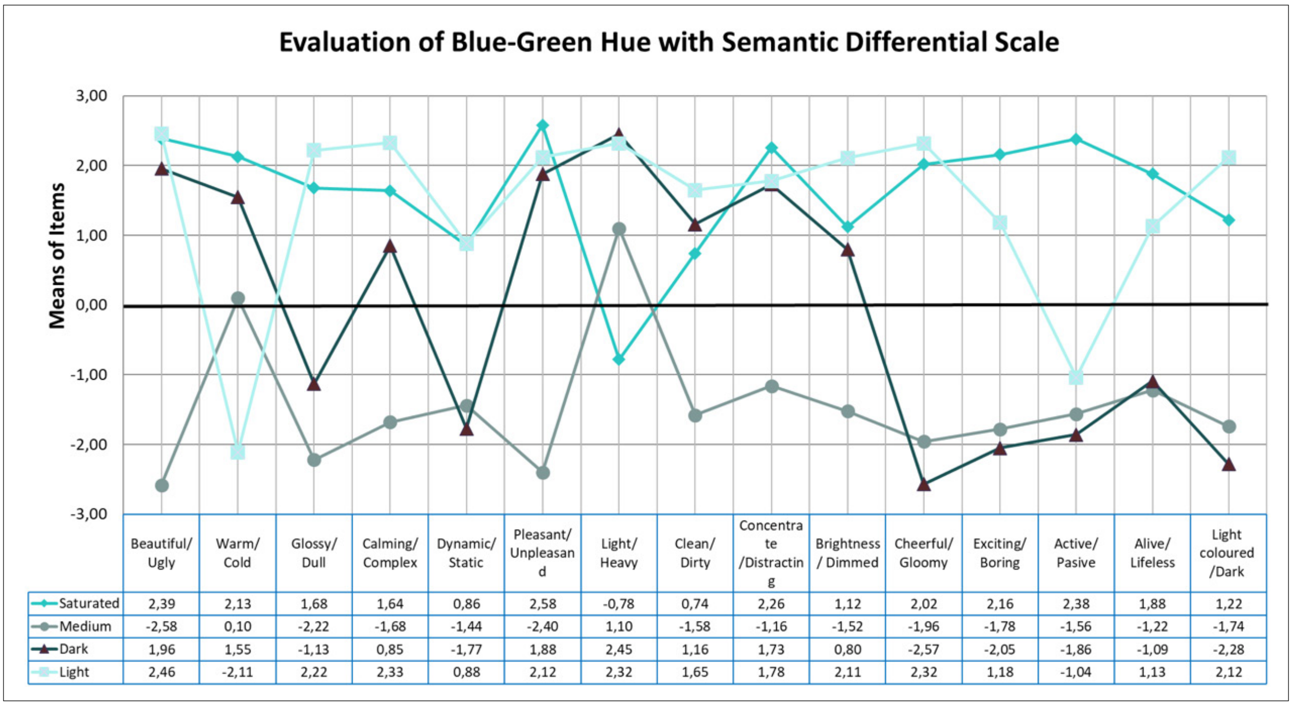
Table 1. Arithmetic mean results of SD scale

Semantic Differential/	Purple (7P)				Blue-Green (7BG)				Red (7R)			
Bipolar Adjectives	Saturated Mean	Medium Mean	Dark Mean	Light Mean	Saturated Mean	Medium Mean	Dark Mean	Light Mean	Saturated Mean	Medium Mean	Dark Mean	Light Mean
Beautiful/Ugly	2.30	-2.62	2.45	1.43	2.39	-2.58	1.96	2.46	2.41	-1.86	1.89	2.11
Warm/Cold	2.70	-1.85	0.25	-1.79	2.13	0.10	1.55	-2.11	2.88	1.12	0.84	-0.50
Glossy/Dull	2.10	-1.30	-0.50	1.92	1.68	-2.22	-1.13	2.22	2.65	-2.02	-1.13	2.22
Calming/Complex	0.43	0.19	0.19	2.15	1.64	-1.68	0.85	2.33	1.84	-1.65	-1.72	2.15
Dynamic/Static	1.80	-2.60	-2.60	0.12	0.86	-1.44	-1.77	0.88	2.76	-1.53	-2.11	2.41
Pleasant/Unpleasant	2.21	1.94	1.94	1.56	2.58	-2.40	1.88	2.12	2.32	-2.38	0.23	1.96
Light/Heavy	0.90	0.74	0.74	2.65	-0.78	1.10	2.45	2.32	1.30	-2.30	1.47	2.32
Clean/Dirty	2.01	2.84	2.84	2.85	0.74	-1.58	1.16	1.65	2.44	-1.02	1.85	2.24
Concentrate/Distracting	1.75	0.23	0.23	0.79	2.26	-1.16	1.73	1.78	-1.66	0.47	1.73	1.78
Brightness/Dimmed	0.60	2.75	2.75	2.86	1.12	-1.52	0.80	2.11	1.97	-1.53	2.54	2.11
Cheerful/Gloomy	2.30	-2.57	-2.57	2.23	2.02	-1.96	-2.57	2.32	2.78	-1.65	-2.57	2.32
Exciting/Boring	2.86	-2.92	-2.92	1.36	2.16	-1.78	-2.05	1.18	2.92	-1.14	-2.05	1.18
Active/Passive	2.43	-1.25	-1.25	0.58	2.38	-1.56	-1.86	-1.04	2.83	-1.56	-1.86	-1.04
Alive/Lifeless	2.75	0.27	0.27	1.90	1.88	-1.22	-1.09	1.13	2.61	-1.22	-1.09	0.59
Light colored/Dark	-0.65	-2.57	-2.57	2.92	1.22	-1.74	-2.28	2.12	1.32	-1.74	-2.28	2.12



	Beautiful/ Ugly	Warm/ Cold	Glossy/ Dull	Calming/ Complex	Dynamic/ Static	Pleasant/ Unpleasand	Light/ Heavy	Clean/ Dirty	Concentrate / Distracting	Brightness/ Dimmed	Cheerful/ Gloomy	Exciting/ Boring	Active/ Pasive	Alive/ Lifeless	Light coloured /Dark
Saturated	2,41	2,88	2,65	1,84	2,76	2,32	1,30	2,44	-1,66	1,97	2,78	2,92	2,83	2,61	1,32
Medium	-1,86	1,12	-2,02	-1,65	-1,53	-2,38	-2,30	-1,02	0,47	-1,53	-1,65	-1,14	-1,56	-1,22	-1,74
Dark	1,89	0,84	-1,13	-1,72	-2,11	0,23	1,47	1,85	1,73	2,54	-2,57	-2,05	-1,86	-1,09	-2,28
Light	2,11	-0,50	2,22	2,15	2,41	1,96	2,32	2,24	1,78	2,11	2,32	1,18	-1,04	0,59	2,12

Figure 8. SD Scale results of 7R (Red) Hue.

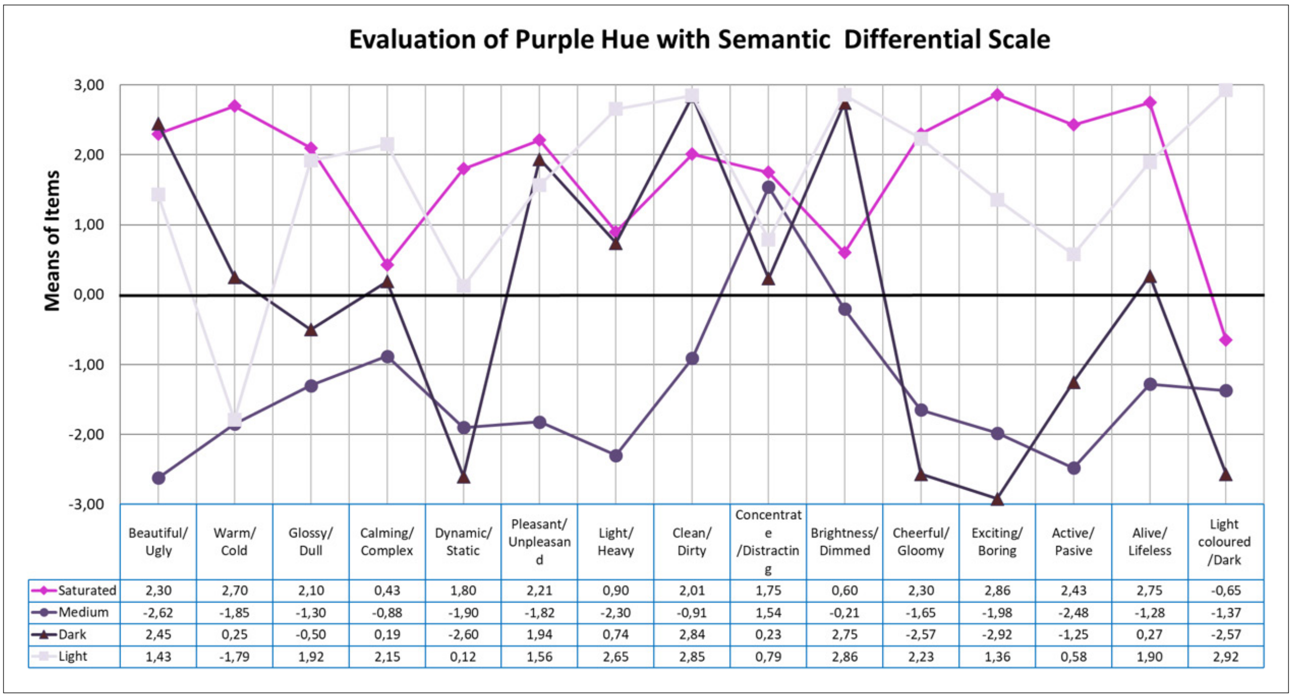


	Beautiful/ Ugly	Warm/ Cold	Glossy/ Dull	Calming/ Complex	Dynamic/ Static	Pleasant/ Unpleasand	Light/ Heavy	Clean/ Dirty	Concentrate /Distracting	Brightness / Dimmed	Cheerful/ Gloomy	Exciting/ Boring	Active/ Pasive	Alive/ Lifeless	Light coloured /Dark
Saturated	2,39	2,13	1,68	1,64	0,86	2,58	-0,78	0,74	2,26	1,12	2,02	2,16	2,38	1,88	1,22
Medium	-2,58	0,10	-2,22	-1,68	-1,44	-2,40	1,10	-1,58	-1,16	-1,52	-1,96	-1,78	-1,56	-1,22	-1,74
Dark	1,96	1,55	-1,13	0,85	-1,77	1,88	2,45	1,16	1,73	0,80	-2,57	-2,05	-1,86	-1,09	-2,28
Light	2,46	-2,11	2,22	2,33	0,88	2,12	2,32	1,65	1,78	2,11	2,32	1,18	-1,04	1,13	2,12

Figure 9. SD Scale results of 7BG (Blue-green) Hue.

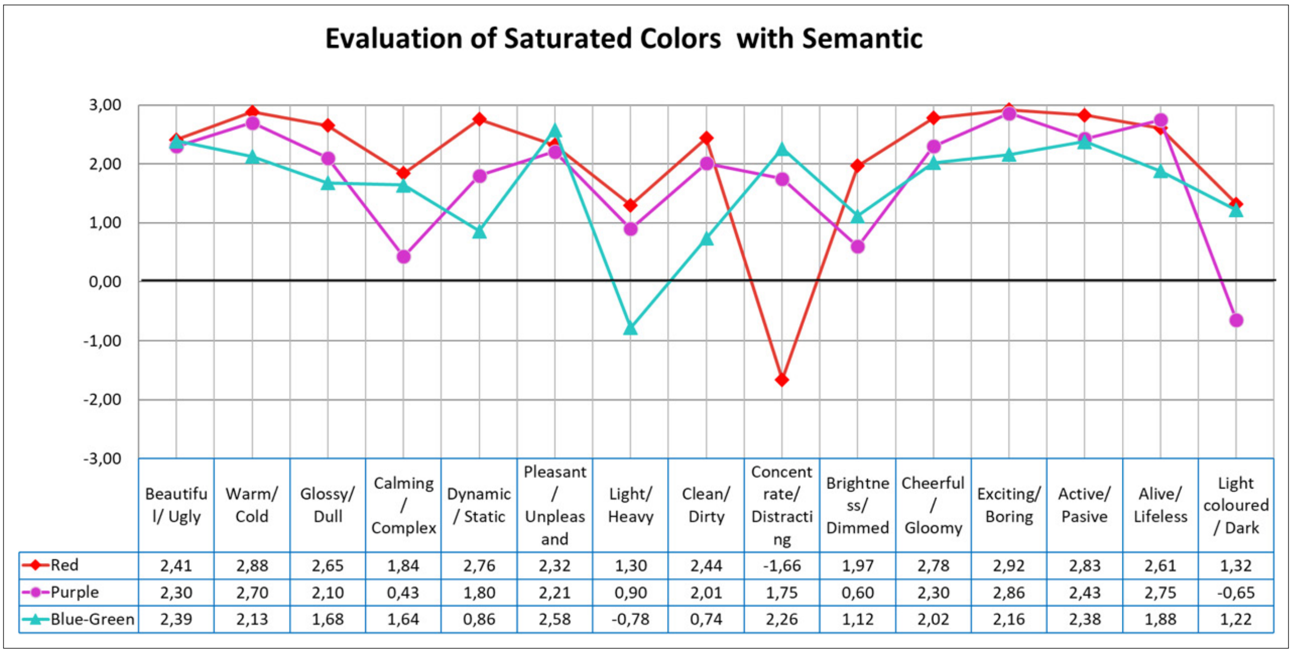
The SD scale results were evaluated in terms of saturated, medium, light, and dark colors of the three hues; the relationship between them can be discerned from the graphs in Figures 11a-d.

According to these results, most of the semantic responses to the saturated colors are on the positive side of the graph and show similar results with each other. Only the saturated red color was found slightly distracting, and the blue-green color was perceived as somewhat heavy (Figure 11a). The "medium" colors of each hue, on the other hand, mostly reside in the negative zone of the graph. These parallel evaluations in the medium colors of all hues indicate that these colors are generally not perceived positively (Figure 11b).



	Beautiful/ Ugly	Warm/ Cold	Glossy/ Dull	Calming/ Complex	Dynamic/ Static	Pleasant/ Unpleasand	Light/ Heavy	Clean/ Dirty	Concentrate /Distracting	Brightness/ Dimmed	Cheerful/ Gloomy	Exciting/ Boring	Active/ Pasive	Alive/ Lifeless	Light coloured /Dark
Saturated	2,30	2,70	2,10	0,43	1,80	2,21	0,90	2,01	1,75	0,60	2,30	2,86	2,43	2,75	-0,65
Medium	-2,62	-1,85	-1,30	-0,88	-1,90	-1,82	-2,30	-0,91	1,54	-0,21	-1,65	-1,98	-2,48	-1,28	-1,37
Dark	2,45	0,25	-0,50	0,19	-2,60	1,94	0,74	2,84	0,23	2,75	-2,57	-2,92	-1,25	0,27	-2,57
Light	1,43	-1,79	1,92	2,15	0,12	1,56	2,65	2,85	0,79	2,86	2,23	1,36	0,58	1,90	2,92

Figure 10. SD Scale results of 7P (Purple) Hue.

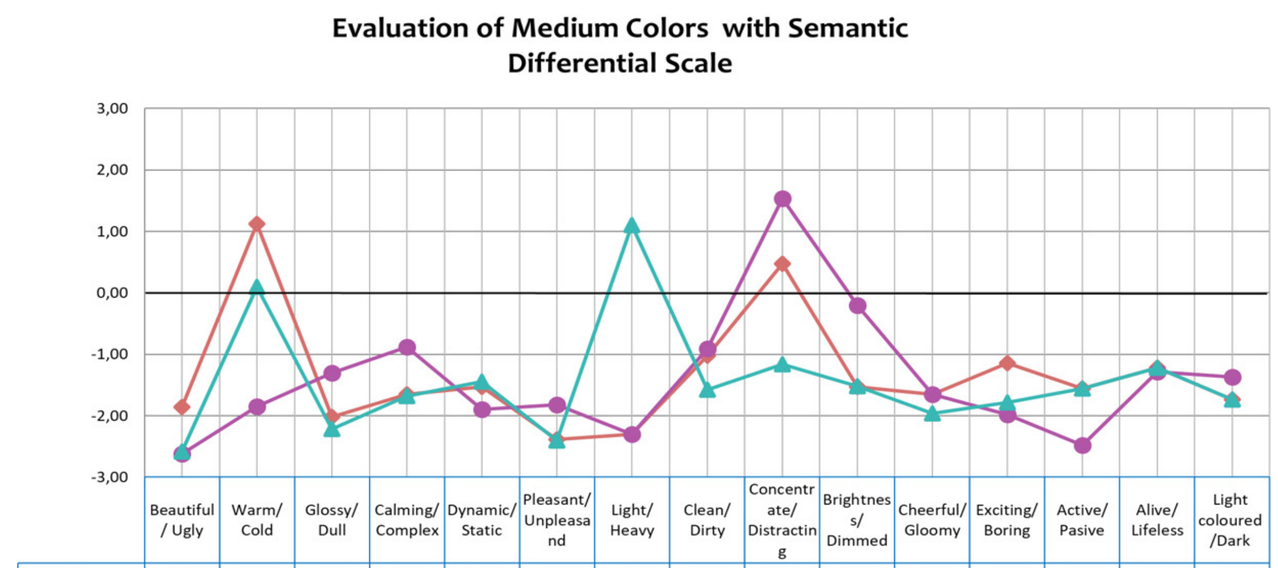


	Beautiful/ Ugly	Warm/ Cold	Glossy/ Dull	Calming / Complex	Dynamic / Static	Pleasant / Unpleasand	Light/ Heavy	Clean/ Dirty	Concentrate/ Distracting	Brightness/ Dimmed	Cheerful / Gloomy	Exciting/ Boring	Active/ Pasive	Alive/ Lifeless	Light coloured / Dark
Red	2,41	2,88	2,65	1,84	2,76	2,32	1,30	2,44	-1,66	1,97	2,78	2,92	2,83	2,61	1,32
Purple	2,30	2,70	2,10	0,43	1,80	2,21	0,90	2,01	1,75	0,60	2,30	2,86	2,43	2,75	-0,65
Blue-Green	2,39	2,13	1,68	1,64	0,86	2,58	-0,78	0,74	2,26	1,12	2,02	2,16	2,38	1,88	1,22

Figure 11 (a). Evaluation of Saturated Colors with Semantic Differential Scale.

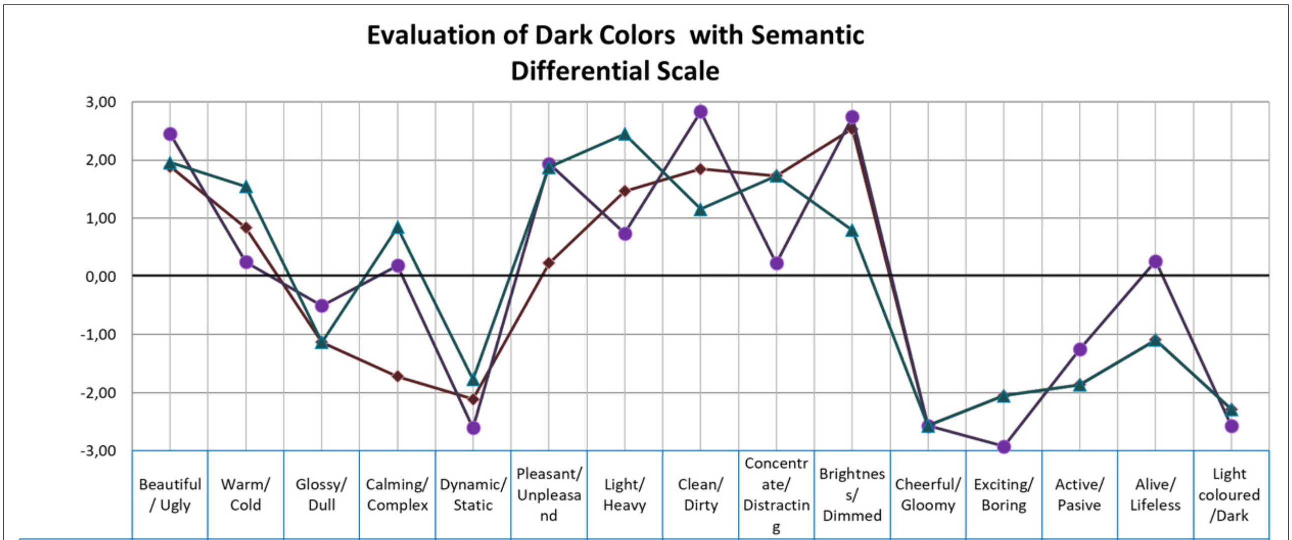
As depicted in Figure 11c, "light" (high value) colors are positioned on the positive side of the graph, and this indicates nearly parallel and similar perceptual evaluations for all light colors of different hues. Students characterize light colors with positive adjectives such as "pleasant, beautiful, warm, cheerful, relaxing, exciting, and active," while considering them "cold and passive" across all three hues. Despite red being predominantly associated with warmth in prior studies, the light red (pink) color was described as cold in this study by participants. This result implies that, regardless of whether a color is warm or cool, if it has a high value, the color of space will be perceived as cool.

The semantic evaluations given for dark colors exhibit parallelism for almost all adjectives, as shown in Figure 11d. Dark colors are found to be positive with descriptors such as "pleasant, beautiful, and light," but they also carry negative connotations like "stationary, gloomy, 'boring,' passive, and dark." Additionally, it can be inferred that these



	Beautiful / Ugly	Warm/ Cold	Glossy/ Dull	Calming/ Complex	Dynamic/ Static	Pleasant/ Unpleasand	Light/ Heavy	Clean/ Dirty	Concentrate/ Distracting	Brightness/ Dimmed	Cheerful/ Gloomy	Exciting/ Boring	Active/ Pasive	Alive/ Lifeless	Light coloured /Dark
RED	-1,86	1,12	-2,02	-1,65	-1,53	-2,38	-2,30	-1,02	0,47	-1,53	-1,65	-1,14	-1,56	-1,22	-1,74
PURPLE	-2,62	-1,85	-1,30	-0,88	-1,90	-1,82	-2,30	-0,91	1,54	-0,21	-1,65	-1,98	-2,48	-1,28	-1,37
BLUE-GREEN	-2,58	0,10	-2,22	-1,68	-1,44	-2,40	1,10	-1,58	-1,16	-1,52	-1,96	-1,78	-1,56	-1,22	-1,74

Figure 11 (b). Evaluation of Medium Colors with Semantic Differential Scale.



	Beautiful / Ugly	Warm/ Cold	Glossy/ Dull	Calming/ Complex	Dynamic/ Static	Pleasant/ Unpleasand	Light/ Heavy	Clean/ Dirty	Concentrate/ Distracting	Brightness/ Dimmed	Cheerful/ Gloomy	Exciting/ Boring	Active/ Pasive	Alive/ Lifeless	Light coloured /Dark
Red	1,89	0,84	-1,13	-1,72	-2,11	0,23	1,47	1,85	1,73	2,54	-2,57	-2,05	-1,86	-1,09	-2,28
Purple	2,45	0,25	-0,50	0,19	-2,60	1,94	0,74	2,84	0,23	2,75	-2,57	-2,92	-1,25	0,27	-2,57
Blue-Green	1,96	1,55	-1,13	0,85	-1,77	1,88	2,45	1,16	1,73	0,80	-2,57	-2,05	-1,86	-1,09	-2,28

Figure 11 (c). Evaluation of Dark Colors with Semantic Differential Scale.

colors are perceived as 'concentrated' by the students.

In the classification of saturated, medium, light, and dark colors within their respective categories, it is observed that there are similar perceptual evaluations in the graphs. This inference leads to the conclusion that, even when different hues (such as red, blue etc.) are applied to the walls of a space, similar values and saturations in each hue can result in resembling perceptions.

CONCLUSION AND DISCUSSION

The colors in our environment not only facilitate our perception and understanding of the spaces we inhabit but also have physiological, cognitive, affective, and behavioral effects on users. Spaces may require dynamic environments for activities such as dining, conversation, dancing, etc., as well as serene settings for activities like relaxation, sleep, and study. In this context, space colors should be organized accordingly. This study focuses on wall colors of a computer

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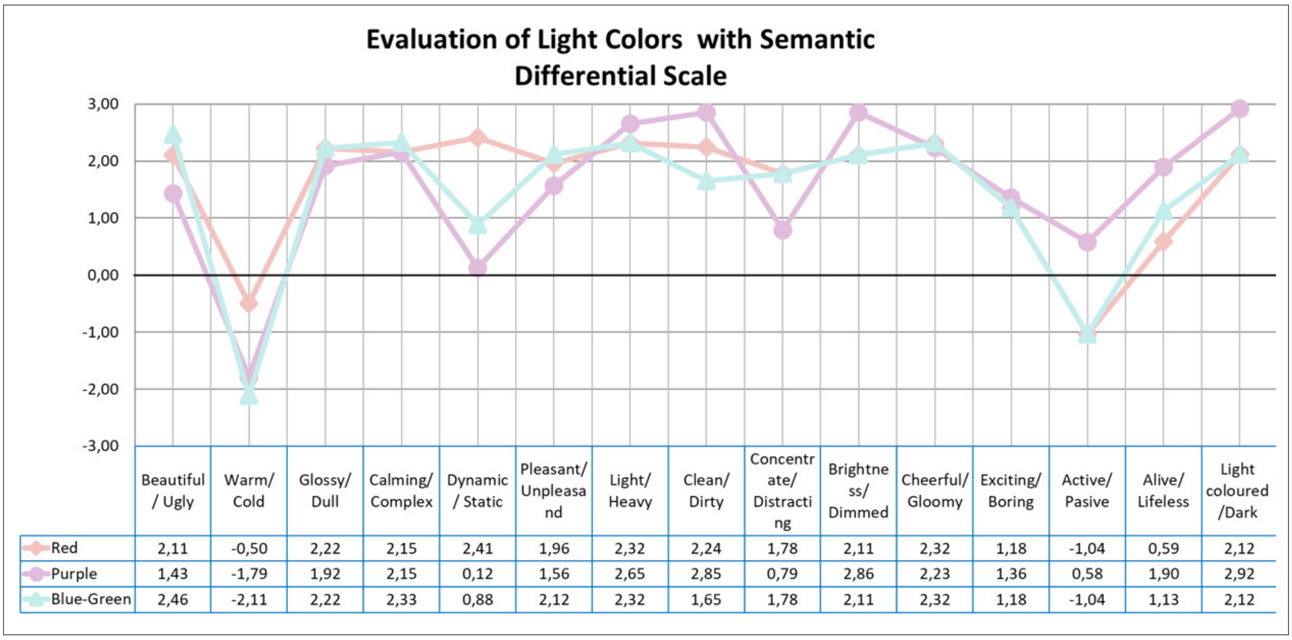

	Beautiful / Ugly	Warm/ Cold	Glossy/ Dull	Calming/ Complex	Dynamic / Static	Pleasant/ Unpleasand	Light/ Heavy	Clean/ Dirty	Concentrate/ Distracting	Brightness/ Dimmed	Cheerful/ Gloomy	Exciting/ Boring	Active/ Pasive	Alive/ Lifeless	Light coloured /Dark
Red	2,11	-0,50	2,22	2,15	2,41	1,96	2,32	2,24	1,78	2,11	2,32	1,18	-1,04	0,59	2,12
Purple	1,43	-1,79	1,92	2,15	0,12	1,56	2,65	2,85	0,79	2,86	2,23	1,36	0,58	1,90	2,92
Blue-Green	2,46	-2,11	2,22	2,33	0,88	2,12	2,32	1,65	1,78	2,11	2,32	1,18	-1,04	1,13	2,12

Figure 11 (d). Evaluation of Light Colors with Semantic Differential Scale.

classroom environment designed for learning purposes, investigating the effects of three different color hues with various values and saturations on the spatial perceptions of users. The results derived from the data are discussed below.

Commonly, high value (light) and saturated colors of all hues of wall colors were perceived positively, with light colors being evaluated as "cool and passive." This result indicates that, even if a color (hue) belongs to the warm category, lighter colors of the respective hue can be perceived as cooler, highlighting the role of value and saturation in the perception of warm/cold colors.

Largely, it is observed that blue is the most preferred color in the literature (Brill, 1984-1985; Camgöz, 2000). In this study, the positive perception of only light, saturated, and partially dark colors of blue shows that the role of value and saturation is also very important in the preference of color. In this context, when defining colors in similar studies, not only the hue of the color such as blue or red but also the contribution of its other two components as value and saturation should be specified.

Medium colors, on the other hand, were perceived negatively with definitions such as "static, boring, dark". While dark colors were perceived positively as "pleasant, beautiful, clean, and bright" but negatively as "gloomy, boring, passive, lifeless, and dark," they were perceived negatively with the definition “static, boring, and dark”. Dark red and dark blue-green colors and all colors of the purple hue were perceived as concentrating colors.

Consistent with findings in the literature, this study revealed that saturated red is perceived as “exciting, dynamic, and active,” while also creating a “distracting” effect (Kaya & Epps, 2004; Küller et al., 2009; Elliout, 2015; Wilson, 1966; Xia et al., 2016; Coutinho & Akbay, 2023). It conveys the idea that the association between red and failure found in many studies might be attributed to the challenging impact it has on focus (Mehta & Zhu, 2009; Moller et al., 2009; Kwallek et al., 1988). Similarly, in the study conducted by Elliot and colleagues, it was concluded that being in a red environment or seeing the red color in the context of success can undermine performance in challenging tasks (Elliot et al., 2007; Elliot, 2015).

In the comparisons for the saturated, medium, light, and dark colors of each of the three hues, it is generally observed that responses to the SD scale yield similar results within their respective categories. This indicator suggests that in spatial color assessments, colors of different types but with similar values and saturations may elicit similar perceptions.

When learning spaces are consciously designed with consideration of the effects of colors, they can contribute to students' active learning, exploration, socialization, research, thinking, and creativity, providing an enjoyable environment. In this context, the objective of this study, which explores high school students' perceptions of classroom wall colors, is to help establish an environment that enhances students' enthusiasm and motivation for learning through environmental colors. In the next stage, evaluating classroom wall colors using different colors or methods will contribute to the literature within the framework of education. Eventually, conducting more comprehensive studies with a variety of colors for educational spaces, where people spend a significant part of their lives, will be beneficial in creating efficient and more enjoyable environments for students.

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