

# The Effect of Educational Background on Students' Color Preferences for Improving the Quality of Learning in Learning Environments (A Case Study: Undergraduate Students Majoring in Computer and Architecture in Mashhad)

Hooman Dehvani <sup>a</sup>, Iman Mirshojaeian Hosseini <sup>b\*</sup>, Seyyed Mehdi Maddahi <sup>c</sup>

<sup>a</sup> Department of Architecture, Khavaran Institute of Higher Education, Mashhad, Iran.

<sup>b</sup> Department of Architecture, Ferdows Institute of Higher Education, Mashhad, Iran.

<sup>c</sup> Construction Engineering System Organization of Khorasan Razavi Province, Mashhad, Iran.

Received: 01 August 2022 - Accepted: 26 January 2023

Doi: 10.22094/SOIJ.2023.1964514.1506

## Abstract

Research has shown the effect of classroom environment variables on students' learning performance. Color, as a variable in the interior space, has greatly impacts on the audience's perception of the environment. Using students' color preferences in classes can have a significant effect on the quality of their learning. Numerous factors can affect people's color preferences, but the question is whether educational background plays a role or not. The present study aims to evaluate the effect of educational background on students' color preferences, so that an appropriate color will be chosen for classroom interiors to improve the quality of learning in educational environments based on the impact of choosing a given color. A total of 618 undergraduate participants majoring in computer sciences and architecture from both genders were evaluated. In a qualitative questionnaire, students were asked to choose their first color preference as the color of the classroom interior, afterward, they should choose their favorite color. SPSS and Pearson's chi-squared test were used to evaluate this test. The results indicated that there is no significant relationship between students' choice of color and their educational background in both majors (computer and architecture). However, the students' color preferences in choosing a color for the classroom's interior in both disciplines are affected by their educational background. This research helps us understand how to use color in learning environments to increase the quality of learning.

**Keywords:** Improving the quality of learning; Educational background; Color preferences; Internal learning environment

## 1. Introduction

One of the designer's responsibilities is to identify and improve the effective environmental factors to strengthen the link between the person and (Karimifard & Tabatabaei Malazi, 2017). In addition, specialized designing of indoor environments should be conducted for increasing the efficiency of the environment and serve its users. In fact, interior design in architecture should be such as to increase the quality of the environment. Therefore, improving the quality of learning is a topic that has always been discussed in educational environments, and by recognizing the evolutionary learning needs of individuals, in designing educational environments, thinking about processes that increase the quality of learning in learning environments has increased. In fact, the purpose of designing an educational environment can primarily be designing to increase the efficiency of an environment. As students are looking to learn in an educational environment, proper designing of learning environments will thus have a positive effect on increasing quality (Barrett et al., 2013). In addition, how a particular learning environment affects students' learning ability and learning experience is important (Askarizad et al., 2021).

Classroom environmental conditions can increase

students' satisfaction with the course (Han et al., 2018). This can increase the quality of teaching and learning in learning environments. One of the changes in learning environments that can improve learning is physical changes in a classroom environment (Kariippanon et al., 2018). In fact, the physical environment affects learning in terms of motivation and enthusiasm (Demir-Yildiz & Tatik, 2019). One of the significant changes in the classroom interior is the change in the color of the classroom walls. Color is one of the components that is less evaluated in the interior design of educational environments. The results have indicated that the color of an interior will affect many different levels (Küller et al., 2009). In addition to the visual effects that colors make in the environment, they can also bring about mental effects on people. The results of a study have shown that wall color has an effective role in the learners' concentration in a classroom; considering this factor in the design of classrooms results in improved behavior and quality of their education in learning environments (Pourbagher et al., 2021). Color is one of the parameters that significantly affects students' progress and has a major impact on changing student performance in the classroom (Barrett et al., 2013). In fact, colors are stimuli that exist in educational environments and can have negative and

\* Corresponding Author Email Address: [Imanmirshojaeian@yahoo.com](mailto:Imanmirshojaeian@yahoo.com)

positive effects on people and their learning. Moreover, the results of another study have indicated that students' characteristics, such as gender, age and educational grade can have significant effects on students' learning space preferences (Beckers et al., 2016). It is also noteworthy that the diversity of students' perceptions of classroom space can have negative effects on students' academic progress (Schenke et al., 2017). Thus, it will be beneficial that designers of learning spaces, based on these characteristics of students, assess their understanding of the physical environment of their classroom and give due attention to the way it affects student learning. However, in creating and designing learning environments, students' initial understanding of these spaces are rarely taken into account. For example, in most of the educational environments such as universities, regardless of students' interests, white is used as the color of the walls, the students' interests in choosing the color of the classroom interior can be different, though. However, it should be noted that studies have shown that the color of the classroom affects the mood, behavior, and performance of its users (Gaines & Curry, 2011). As a result, the users' interests of an educational environment should be considered in terms of the physical conditions of that environment, such as the color of the classroom walls. Additionally, there is evidence that the environment and social situation have something to do with creating a color preference. Recent studies found that educational experiences affect non-cognitive skills, including personality traits (Jackson, 2011). Personality is a set of habitual behaviors, cognitive, and emotional patterns that are evolved by biological and environmental factors (Corr & Matthews, 2020). Personality is a set of emotional characteristics and behavioral patterns that distinguish each individual and also plays a crucial role in determining who to date based on psychological factors like color preferences. Research has demonstrated that a person's personality can affect their choice of study field (Humburg, 2017). It is also believed that educational background affects personality traits; on the other hand, personality traits also influence individual choices, including color preferences (Hanafy & Sanad, 2015). Thus, the educational background can affect color preferences, and also colors can affect the amount and quality of people's learning.

However, the most recent literature demonstrates that there are rarely studies determining the effect of educational background (in terms of undergraduate education) on color preferences. For instance, studies by (Bakker, van der Voordt, et al., 2015) have demonstrated a significant positive correlation between favorite colors and education. According to this study, university-educated people mostly selected blue, while professionals preferred light green and pink. In contrast, in another study (Cubukcu & Kahraman, 2008) conducted among art students and non-art students, the color preference scale was similar between the two groups, and educational background did not affect color preference. So, based on the above, we can say that an individual's educational background can influence their color preferences and the amount and quality of their learning can also be affected by their color preferences.

Numerous studies have indicated that different factors affect people's color preferences, and factors that have been evaluated in various studies include age (Beke et al., 2008; Read & Upington, 2009), gender (Huang & Xu, 2009; van der Voordt et al., 2017), seasonal changes (Schloss et al., 2017) and many other factors. However, there is a research gap in this regard and very few studies have been conducted on the effect of educational background on students' color preferences.

As students have different interests in different majors and each chooses a different field of study, the question posed here is whether the educational background affects the color preference of individuals and whether the student's major is important in choosing the color of the classroom interior, and whether designers are required to determine the color of the classroom interior according to the effect of students' educational background. In fact, the purpose of the present study is to determine whether students' educational background affects their color preferences and whether this effect works the same in different fields or not, so that it can be used in choosing the appropriate color for their learning environment and increase their learning rate. Thus, two hypotheses are proposed, the first being that educational background affects students' color preferences (as a favorite color). Secondly, educational background affects students' color preferences (as the favorite color for the classroom interior). The relationship between educational background and color preferences in line with the increase in students' learning rate is presented in Figure 1.

## **2. Theoretical Foundations and Review of The Related Literature**

### *2.1 Educational background*

Many aspects of a person's life can be influenced by their educational background at any stage of their lives. In fact, it can also influence decision-making, choice power, goal-setting, and other factors. In this regard, a number of studies have been conducted to investigate the effects of educational background on different factors (Gabarró-López, 2020; Gottesman & Morey, 2010; Kusurkar et al., 2010). For instance, the research of (Tikka et al., 2000) has evaluated the impact of the educational background of students in different educational institutions on their attitudes toward nature and the environment. An additional study (Mun et al., 2020) examined how managers' educational backgrounds affected cash retention policies and excess liquidity value in Korean companies. Specifically, this study indicates that the company's financial policy is influenced by the educational background of its managers, which affects their characteristics and their professional work experience, resulting in different managers' performance. Thus, based on the conducted research, it would be said that examining the effects of educational background in different aspects can be valuable. One of the factors that the educational background can influence is related to emotions and the power of choice related to it, such as selecting and preferring a color for a specified environment.

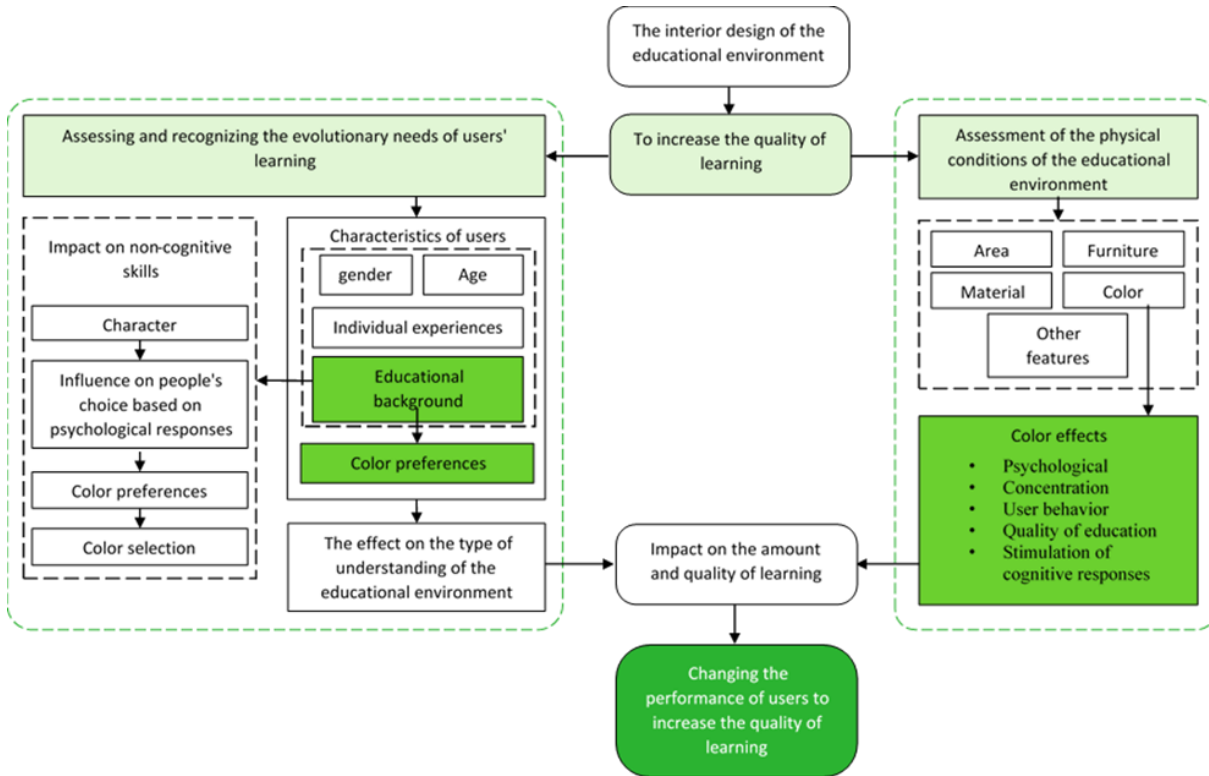


Fig. 1. The relationship between educational background and color preferences in line with increase students' learning rate.

## 2.2 Color preferences

However, the question that has always been posed is what factors affect people's color preferences. Previous studies have evaluated the effects of many components on color preferences, such as age and gender (van der Voordt et al., 2017). For example, the results of a study have indicated that pink is a symbol of women and blue is a symbol of men (Del Giudice, 2012). As a result, given the effect of gender on choosing colors, this test has separately considered the effect of educational background in both males and females. Other components include the effects of cultural contexts. A researcher named Eysenck claimed that color preference is universal in humans (Eysenck, 1941). Other researchers, such as Adams and Osgood have suggested that similar color meanings exist in different countries (Adams & Osgood, 1973). However, further studies have indicated that there are cultural differences in color preference (Baniani & Yamamoto, 2015; Sorokowski et al., 2014; Taylor et al., 2013). For example, the "blue phenomenon", which refers to the tendency to choose blue as the most popular color, was not observed in participants from Brazil, Hong Kong, and Canada (Madden et al., 2000). Therefore, considering the impact of the cultural context, this research must be evaluated separately in each country and in each region, since it is likely that. Moreover, in choosing people's color preferences, the field being investigated is effective and causes a change in the choice of color for different people. In fact, the meaning of colors changes in different conditions for humans, and humans do not follow and choose a specific color in all conditions. For example, in a study conducted on female students, it was shown that

people preferred blue as the color of their clothes, but the same people preferred white as the color of their living room (Hanafy & Sanad, 2015).

Interestingly, based on Humphrey's theory (Humphrey, 1971) and his research on the behavior of rhesus monkeys, it has been stated that human reactions to color are inherent and have a universal pattern, and that such an adaptation is the result of evolution for biological survival. However, contrary to this theory, in his research, Crozier has stated that human reactions to color are more instructive than instinctive and depend on the social experience of each individual (Crozier, 1996). This suggests that the reaction to color can be different due to the different experiences that each person has in different contexts.

## 2.3 Learning environment

Physical elements can effectively affect how people behave and use space (Feli et al., 2020). In addition to the fact that students' progress is affected by the quality of the learning environment (MacMahon et al., 2020), the results clearly indicate that the physical environment in which students study has a great impact on their learning outcomes (Brooks, 2011). In recent years, numerous studies have been conducted on the effect of learning environment on the quality of learning (Carvalho et al., 2020; Hao et al., 2021; Mäkelä et al., 2018). For instance, the result of (Barrett et al., 2015) shows that, evaluations of 153 classrooms in 27 schools have been carried out, to identify the effect of the physical characteristics of the classroom on the academic achievement of 3766 students. Finally, seven key design parameters were identified,

which explain a total of 16% of the variation in students' academic achievement. These parameters have been consisted of light, temperature, air quality, ownership, flexibility, complexity, and color. Moreover, the (Loisos, 1999) studies have shown that children in classrooms with the most daylight and the largest windows progressed approximately 20% faster in math and reading. Therefore, based on the literature review, it can be stated that there is an important research challenge in the field of better understanding and proving the effects of learning environments on users, and the optimization of a learning environment can have very wide effects on the amount and quality of learning of its users.

#### *2.4 Color and quality of learning*

Numerous physical factors have been studied in learning environments, including the effect of color in the classroom environment on learning. In fact, colors can also affect people's behavior (Elliot & Maier, 2014). Colors can have physiological effects on people as well, such as changes in heart rate (AL-Ayash et al., 2016), and they can also have psychological effects (Brooker & Franklin, 2016; Elliot & Maier, 2014). However, the effect of colors depends on the context. For example, a study has shown that red can cause avoidance behavior in people (Genschow et al., 2012) or another study has shown that understanding red weakens the individual's IQ test performance (Maier et al., 2008). Yet, in another study it has been stated that in some cases, red is associated with attractiveness and can motivate individuals (Nieta Kayser et al., 2010).

Colors affect people's emotions (Güneş & Olguntürk, 2020). For example, blue and green mainly cause a sense of calm and peace in humans (Clarke & Costall, 2008). These emotions can have greatly affecton people's learning (Eynde et al., 2006; Tyng et al., 2017). In fact, having a positive feeling can enhance learning (Rowe et al., 2015; Wilms & Oberfeld, 2018), so it can be said that colors affect people's learning (Rim & Yoon, 2015). However, different colors have different functions on people's memory (Kuhbandner & Pekrun, 2013). For example, a study has shown that yellow improves math performance, blue improves English memorization skills, and orange improves calculation and comprehension skills (Schloss et al., 2017). Therefore, using students' favorite color in the learning environment not only creates a positive feeling in them and reduces physical fatigue, but it can also increase the quality of their learning.

As a result, it can be stated that many factors can affect people's color preferences, one of which can be educational background. In fact, it should be noted that the effect of the educational background on the choice of colors has been less considered and evaluated. If such a relationship is confirmed, students' color preferences can be used to choose the right color for painting educational environments of each field of study. In addition to other influential factors regarding people's color preferences, this factor was also added to them, so that increasing accuracy in this field can increase the quality of learning. Thus, this shows that evaluating the relationship between

educational background and learning (as one of the factors influencing personality, which in turn influences individual choices including color) is both interesting and effective.

### **3. Material and Methods**

In this study, data were gathered through libraries and questionnaires, and a descriptive and analytical methodology was used. In fact, we obtained the questions of the questionnaire based on the descriptions of available information and literature and then used Pearson's chi-squared test to analyze the results.

#### *3.1 Data collection*

To evaluate the effect of educational background on color preferences, two major i.e. architecture and computer were selected to be evaluated in two different fields of study in which students have different educational experiences. Universities in Mashhad having one of these two fields of study were identified and 10 universities were selected from them using random sampling method. To increase the accuracy of assessing the impact of academic background on color preferences, only undergraduate students who had completed at least 4 semesters were used for the present test, assuming that freshmen and sophomores were likely not to have been affected yet by their academic background. A total of 663 students from both majors volunteered to take part in the experiment. As many as 45 students were excluded from the study, as they were not from Mashhad. A total of 618 students from architecture (155 females and 155 males) and computer (154 females and 154 males) were selected to take the test. The average age of students was 21 years. All the candidates were confirmed to be Iranian and to be from Mashhad, so that the influence of cultural background in the test would be avoided. Before starting the test, students were tested for color blindness (Ishihara), and they were all confirmed to be healthy in this regard. Studies have shown that the difference in color choice and preference is highly noticeable at this age. Moreover, before the college period, the educational backgrounds of people are very similar. Thus, university students were used in this study for the abovementioned reasons.

#### *3.2 Test methodology*

From the 12 main colors of the color cycle (red, red-orange, orange, yellow-orange, yellow, yellow-green, green, blue-green, blue, blue-violet, violet, red-violet) with 3 achromatic colors (i.e. white, gray, black) were used to conduct this test (Table 1). Initially, these 15 colors were printed in squares of the same size with dimensions of 10 by 10 and placed at equal and regular distances from each other in an A<sub>2</sub> size sheet having a gray background. Each student was then taken individually (to avoid students' consult in choosing colors) to the quiet classroom environment. Then, the student was asked to sit at a desk. A test sheet with a questionnaire (in which name, age, gender, and the student's field of study was registered) were provided for

the student and the student was asked to choose one color from the colors on the sheet as his favorite color for painting the interior of the classroom and one color as his/her favorite color in general. As color preferences depend on the subject (Hanafy & Sanad, 2015), for having a more accurate evaluation of whether educational background is effective in all subjects or not, color preferences test was added for the classroom interior. After choosing the intended color, the student registered this color in the questionnaire sheet as his/her first choice in both fields. The test was conducted for every single participant (618 participants). Each student spent around 30 seconds for choosing the colors.

Table 1  
The main colors of the color cycle used in the test

R		Y-G		V	
R-O		G		R-V	
O		B-G		W	
Y-O		B		GR	
Y		B-V		BL	

The 12 main colors of the color cycle, in addition to the 3 achromatic colors used in the test, R, RO, O, YO, Y, YG, G, BG, B, BV, V, RV, W, GR, and BL, respectively, which stand for red, red-orange, orange, yellow-orange, yellow, yellow-green, green, blue-green, blue, blue-violet, violet, red-violet, white, gray and black.

Data analysis was conducted using IBM SPSS Statistics. In the following, the frequency of preferred colors as the first priority of students to prefer the favorite color and color of the interior of the classroom were separately expressed for each gender and field of study percentage and number of people who have chosen those colors. In this study, Pearson's Chi-Square test with a significance level of 5% was used to find the relationship between educational background and color preferences of students majoring in architecture and computer science.

Table 2  
Cross-tabulation of color preferences of architecture students and computer students based on percentage and number of people (male students)

architecture students			computer students		
Color	Percentage	Number	Color	Percentage	Number
Blue	25.8	40	Blue	27.9	43
Red	11.6	18	Green	11.7	18
Blue - Green	7.7	12	Blue - Green	9.7	15
Black	7.1	11	Black	9.7	15
Green	7.1	11	Red	9.1	14
White	6.5	10	Gray	6.5	10
Gray	5.2	8	Yellow - Orange	4.5	7
Green - yellow	5.2	8	Green - yellow	3.9	6
Red - Purple	5.2	8	Orange	3.9	6
Yellow	4.5	7	Red - Orange	3.2	5
Orange	4.5	7	White	3.2	5
Red - Orange	3.9	6	Yellow	3.2	5
Yellow - Orange	3.2	5	Red - Purple	1.9	3
Blue - Purple	2.6	4	Blue - Purple	1.3	2

The Chi-Square test is a non-parametric test used to determine the relationship between two nominal variables. This test is widely used in statistical analyses of categorical variables to investigate their ties or difference (Franke et al., 2012). This test examines the independence of two variables to determine whether the difference between observed and expected frequencies is significant or random. Previous studies have shown that the Chi-Square test is one of the most common methods to evaluate research with more than two categorical variables (Rahimi et al., 2021; Roy et al., 2019; Taj et al., 2021). Due to that, this test was used in the current research according to the type of variables studied.

#### 4. Results and Discussion

Test data registered on questionnaires were collected. As the studies of numerous researchers have indicated that color preferences also depend on gender (Bakker, Van Der Voordt, et al., 2015; van der Voordt et al., 2017), the frequency of data for each field as well as their analysis are separately illustrated for each gender.

##### 4.1 Color preferences for favorite color (male students)

In this test, the percentage of colors selected as the favorite color and for the males is as follows (from the highest percentage to the lowest percentages, respectively). For architecture students, the most preferred color is blue, followed by red, blue-green, black, green, white, gray, green-yellow, red-purple, yellow, orange, red-orange, yellow-orange. The least preferred one is blue-violet. As for computer students, the most preferred colors include blue followed by green, blue-green, and black, red, gray, yellow-orange, green-yellow, orange, red-orange, white, yellow, red-purple. The lowest preferred one was blue-violet (Table 2). In general, color preferences for the color of interest in the male students indicate that in both architecture and computer students, blue is the most preferred and blue-violet is the least preferred one (Figure2).

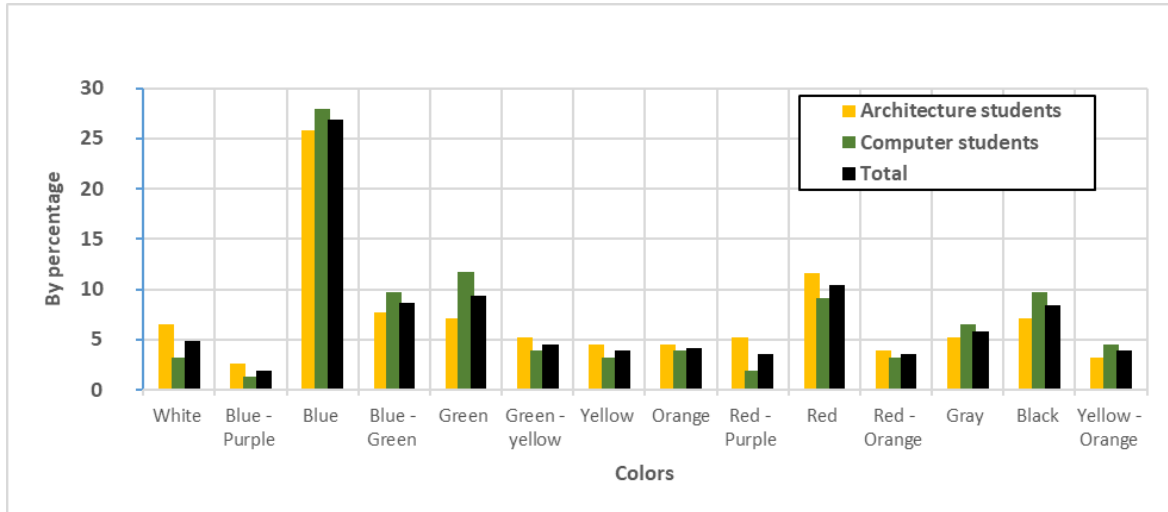


Fig. 2. Color preferences for the favorite color of architecture and computer students (male students)

Using Pearson’s chi-squared test, the relationship between color preferences of male students in both disciplines was evaluated:  $\chi^2 = 9.192$   $p = 0.758$ ;  $\alpha = 0.05$  (Table 3). This indicates that color preferences for the preferred color in

architecture and computer science students (male students) are not affected by their educational background. Thus, the first hypothesis of the test is not confirmed in this case.

Table 3  
Pearson’s Chi-squared test for the favorite color of architecture and computer students (male students)

	Value	df	Asymptotic Significance (2-sided)
<b>Chi-Square Tests</b>	9.192 <sup>a</sup>	13	.758

Value = Pearson’s chi-squared statistic value, df = degree of freedom, p value = Asymptotic Significance (2-sided)

4.2 Color preferences for favorite color (female students)

In this test, the percentage of colors selected as the favorite color and for the females is as follows (from the highest percentage to the lowest percentages, respectively). For architecture students, the most preferred color is blue, followed by red, red-violet, white, green, yellow, blue-green, violet, red-orange, yellow-orange, orange, blue-purple, gray, and black. The least preferred

color was green-yellow. As for computer students the most preferred color was blue followed by red, violet-red, white, green, purple, blue-purple, yellow, green-yellow, blue-green, orange, yellow-orange, black, and red-orange. The least preferred color was gray (Table 4). In general, color preferences for the favorite color in female students indicate that in both architecture and computer sciences, blue is the most preferred color, and gray is the least preferred one (Figure 3).

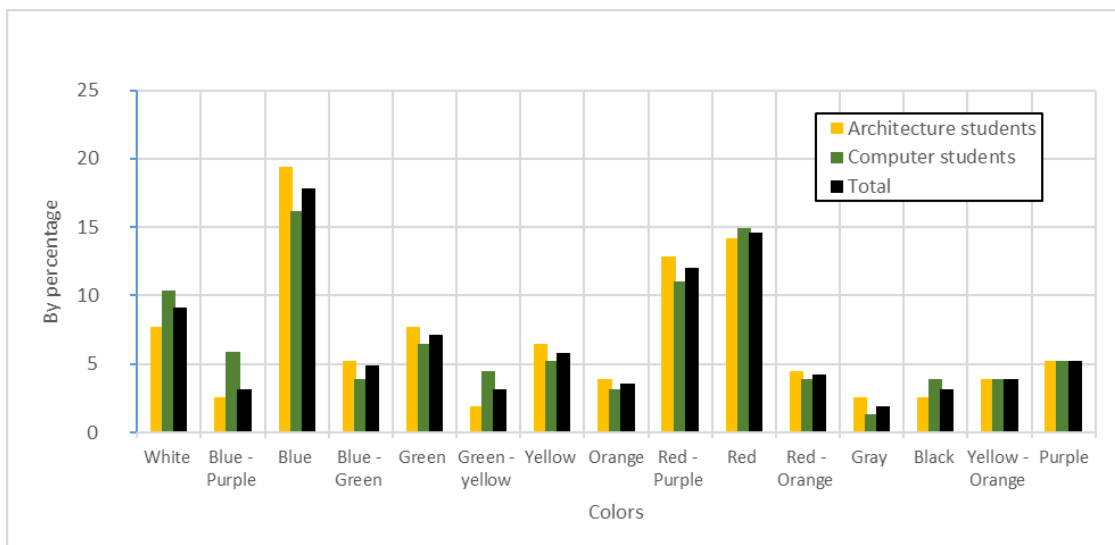


Fig. 3. Color preferences for the favorite color of architecture and computer students (female students)

Table 4

Cross-tabulation of color preferences of architecture students and computer students based on percentage and number of people (Female students)

Architecture Students			Computer Students		
Color	Percentage	Number	Color	Percentage	Number
Blue	19.4	30	Blue	16.2	25
Red	14.2	22	Red	14.9	23
Red - Purple	12.9	20	Red - Purple	11	17
White	7.7	12	White	10.4	16
Green	7.7	12	Green	6.5	10
Yellow	6.5	10	Purple	5.2	8
Blue - Green	5.2	8	Blue - Purple	5.2	8
Purple	5.2	8	Yellow	5.2	8
Red - Orange	4.5	7	Green - yellow	4.5	7
Yellow - Orange	3.9	6	Blue - Green	3.9	6
Orange	3.2	5	Orange	3.9	6
Blue - Purple	2.6	4	Yellow - Orange	3.9	6
Gray	2.6	4	Black	3.9	6
Black	2.6	4	Red - Orange	3.9	6
Green - yellow	1.9	3	Gray	1.3	2

Using Pearson's chi-squared test, the relationship between color preferences of female students in both majors was evaluated:  $\chi^2 = 6.146$ ,  $p = 0.963$ ,  $\alpha = 0.05$  (Table 5). This indicates that color preferences as the favored color in

architecture and computer science (female) students are not affected by their educational background; Thus, the first hypothesis of the test is not confirmed in this case.

Table 5

Pearson's Chi-squared test for the favorite color of architecture and computer students (female students)

	Value	df	Asymptotic Significance (2-sided)
Chi-Square Tests	6.146 <sup>a</sup>	14	.963

Value = Pearson's chi-squared statistic value, df = degree of freedom, p value = Asymptotic Significance (2-sided)

In both majors, architecture and computer science, and for both males and females, blue accounts for the highest percentage as favorite color; this is in line with the findings of other studies researchers (Jonaskaite et al., 2019; Kurt & Osueke, 2014). However, as for the male students, blue-violet accounts for the lowest percentage of color preference in both majors. On the other hand, as for the female students, green-yellow and gray account for the lowest percentage among the architecture and computer students, respectively. In male architecture students, a total of 18.8% of the students chose achromatic colors, 32.8% chose warm colors, and 48.4% chose cool colors. As for male computer students, 19.4% chose achromatic colors, 26.1% chose warm colors, and

54.5% chose colors. In female architecture students, a total of 12.9% students chose achromatic colors, 45.2% chose warm colors, and 41.9% chose cold colors. In female computer students, 15.6% students chose achromatic colors, 42.8% chose colors warm colors, and 41.6% chose cool colors. The results indicate that in general, both majors and both genders, cold colors are more preferred than warm ones; this is in line with the findings of the study conducted by Zhang (Zhang et al., 2019). However, it must be stated that the context being investigated is very influential for color preference.

#### 4.3 Color preferences for the color of the classroom interior (male students)

In this test, the percentage of colors selected as for the color of the interior for the males is as follows (from the highest percentage to the lowest percentages, respectively). For architecture students, the most preferred is white, followed by blue, blue-green, yellow-green, yellow-orange, orange, and yellow. Gray was the least preferred one. As for computer students, the most preferred was white, followed by blue, green-yellow,

yellow, yellow-orange, blue-green, and orange. The least preferred color was gray (Table 6). In general, color preferences for the favorite color as the color of the classroom's interior in the male gender show that for both architecture and computer students, white is the most preferred color, and gray is the least preferred one (Figure 4).

Table 6

Cross-tabulation of color preference of architecture students and computer students for the classroom interior based on the percentage and number of people (male students)

Architecture Students			Computer Students		
Color	Percentage	Number	Color	Percentage	Number
White	23.9	37	White	49.4	76
Blue	14.2	22	Blue	9.1	14
Blue - Green	14.2	22	Yellow - Green	9.1	14
Yellow - Green	11.6	18	Blue - Green	7.8	12
Yellow - Orange	10.3	16	Yellow - Orange	7.8	12
Orange	9	14	Yellow	7.8	12
Yellow	9	14	Orange	6.5	10
Gray	7.7	12	Gray	2.6	4

The color of the classroom's interior was not observed in any of the male students in both majors. Also, blue accounts for a small percentage of the first choice of computer students, while research has shown that blue is the favorite color of the general public (Jonauškaite et al., 2019); this can be due to the effect of the studied background on the choice of color in the male students of

this research. Gray accounts for 7.7% of selected colors in architecture students, which may be due to the knowledge that architecture students have gained about the characteristics of gray.

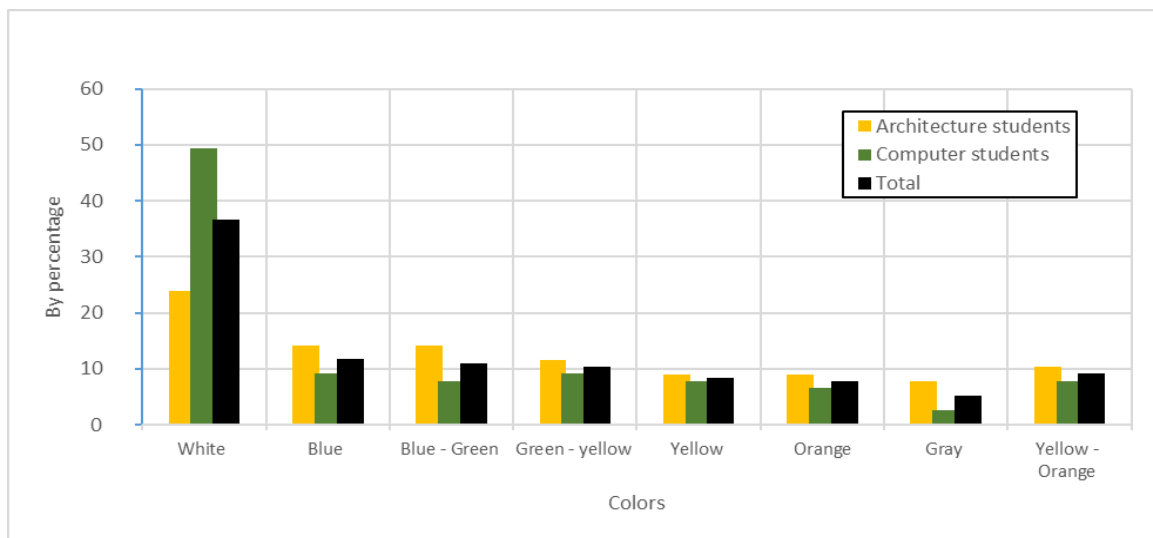


Fig. 4. Color preferences for the favorite color of the classroom among the architecture and computer students (male students)

Using Pearson's chi-squared test, the relationship between color preferences of male students in both majors was evaluated:  $\chi^2 = 24.068$ ;  $p = 0.001$ ;  $\alpha = 0.05$  (Table 7).

This indicates that color preferences as the color of the classroom's interior in architecture and computer science (male gender) students are affected by their educational background. The second hypothesis of the test, in this case, is thus confirmed.



Table 7

Pearson's Chi-squared test for the favorite color of classroom interior in architecture and computer students (male students)

	Value	df	Asymptotic Significance (2-sided)
Chi-Square Tests	24.068 <sup>a</sup>	7	.001

Value = Pearson's chi-squared statistic value, df = degree of freedom, p value = Asymptotic Significance (2-sided)

#### 4.4 Color preferences for the color of the classroom interior (female students)

In this test, the percentage of colors selected as for the color of the interior for the females is as follows (from the highest percentage to the lowest percentages, respectively). For architecture students, the most preferred color was white, followed by blue, green, yellow-orange, yellow, green, green, yellow, and red-violet. The least

preferred color was blue. As for the computer students, the most preferred color was white followed by yellow-green, blue-green, yellow-orange, blue, red-violet, and green. The least preferred was yellow (Table 8). In general, color preferences for the favorite color for the interior of the classroom in females show that in both architecture and computer, white is the most preferred color and blue is the least preferred one (Figure 5).

Table 8

Cross-tabulation of color preference of architecture students and computer students for the classroom interior based on the percentage and number of people (female students)

Architecture Students			Computer Students		
Color	Percentage	Number	Color	Percentage	Number
White	23.2	36	White	44.8	69
Blue - Green	15.5	24	Yellow - Green	13	20
Yellow - Orange	15.5	24	Blue - Green	10.4	16
Yellow - Green	11.6	18	Yellow - Orange	9.1	14
Green	11	17	Blue	7.8	12
Yellow	10.3	16	Red - Purple	5.8	9
Red - Purple	7.7	12	Green	5.2	8
Blue	5.2	8	Yellow	3.9	6

Yellow was the least preferred color for computer students and blue color was the least preferred for architecture students. Violet, red, orange, green, red-

orange, black, gray, and blue-violet were not observed in the first color majors of any of the female students in these two majors.

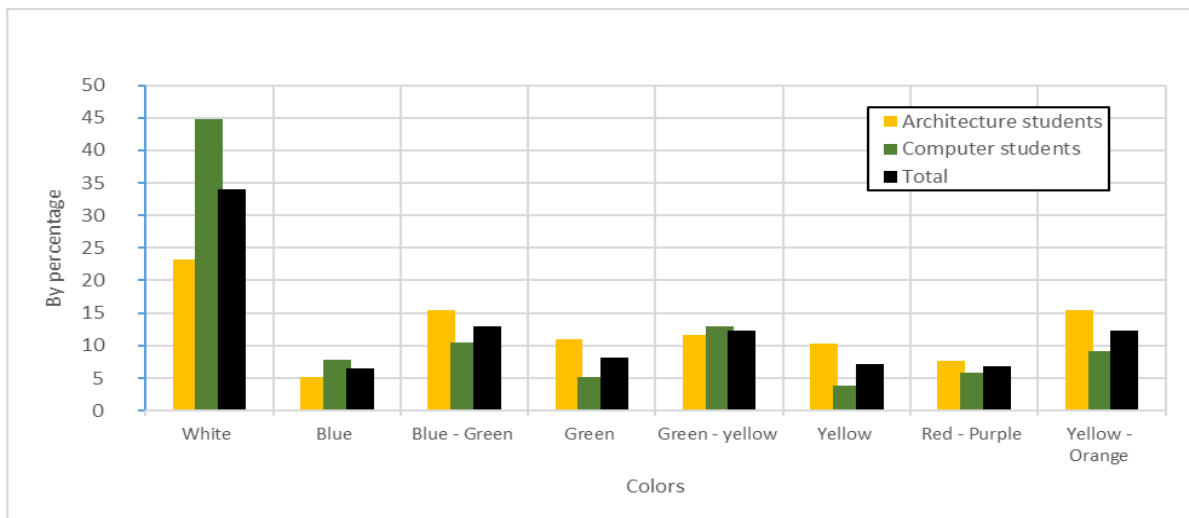


Fig. 5. Color preferences for the favorite color of the classroom among the architecture and computer students (female students)

Using Pearson chi-square test, the relationship between color preferences of female students in both majors was evaluated:  $\chi^2 = 23.719$ ;  $p = 0.001$ ;  $\alpha = 0.05$  (Table 9). This indicates that color preferences as the color of the

classroom interior in architecture and computer science students (female) is largely affected by their educational background. Thus, The second hypothesis of the test, in this case, is confirmed.

Table 9

Pearson's Chi-squared test for the favorite color of classroom interior in architecture and computer students (female students)

	Value	df	Asymptotic Significance (2-sided)
Chi-Square Tests	23.719 <sup>a</sup>	7	.001

Value = Pearson's chi-squared statistic value, df = degree of freedom, p value = Asymptotic Significance (2-sided)

The analysis of this test showed that color preferences are influenced by the field being investigated, even if they occur in a specific group of individuals. The preferences of the students' preferred color over their color preferences as the color of the classroom interior changed depending on the context of the test questions. This indicated that in choosing the color of the classroom interior according to the students' own opinions, the students are required to be asked an appropriate question in this regard, and the results need to be evaluated.

The data also showed that gender is very influential in color selection and it is interesting that although the analysis of the results of the color selection test showed a favorite relationship for students in both male and female students, the choice of color does not have a significant relationship with educational background. Moreover, the analysis of the results of the color selection test for the interior of the classroom showed that, for students of both genders, the choosing one's favorite color for the interior of the classroom has a significant relationship with the educational background. The data analysis showed that in both different areas of the test questions, although according to Pearson's Chi-squared test, the same results were obtained between male and female students, there is still a big difference between the males and females in terms of prioritizing the choice of colors in both areas of the test questions. This result is in line with many studies that consider color choice to be gender-dependent (Bonnardel et al., 2018; Jonauskaitė et al., 2019).

Since most university classroom environments are painted white by default, and while it was speculated that when students are given the right to choose, they will use colors other than white as their first priority, the students of both genders choose to paint the interior of their classroom to be white; white accounted for the highest percentage of color selection and the first priority. This can be attributed to the pattern in coloring, where white is always the color of the classroom. Even, students are afraid to choose another color and may worry about losing their focus in an environment where the tradition is broken and other colors are used instead of the conventional white.

However, the results of data analysis showed that educational background has a significant relationship with students' color preferences for choosing the color of the classroom interior; the second hypothesis of this study was confirmed. Consequently, students' satisfaction and

learning can be increased and improved in an environment that uses their color interests. However, it is important to note that, in spite of the fact that the test results of students in two different fields of computer and architecture revealed the relationship between color preferences as the favorite color for the interior of the classroom with educational background, they still very different in color prioritization. Therefore, it should be considered to take a separate test for each field of study in this regard, and according to the results of that test, the interior of their classroom should be painted; the results of the test of one major cannot be generalized to other majors.

## 5. Conclusion

Given the fact that the quality of students' learning in universities can have a great impact on the future and their society, in recent years, according to the results of research conducted on the effective components in the design of learning environments and to improve the quality of learning, significant attention has been paid to this area and researchers have done a lot of research to find these components. In this study, to increase the quality of learning, students were involved in the process of designing the interior of their classroom at the university, and it was attempted to investigate the effect of educational background on color preferences as the favorite color and the color of choice for the interior of students in both computer and architecture undergraduate students.

The results showed that according to Pearson's Chi-squared test, there is no significant relationship between choosing color as one's preferred color and educational background in students of both architecture and computer and both male and female students. However, when the results of the test question changed from the students' favorite color to the students' favorite color for the classroom interior, the results were different. The results of Pearson's Chi-squared test showed that there is a significant relationship between choosing color as the preferred color for the classroom interior and educational background in both males and females.

According to this study, it can be stated that educational background affects students' color preferences in both males and females for choosing their favorite color for the classroom interior. However, it was also observed that the

results of educational background on color preferences can be different by changing the subject being investigated. As a result, this test can be used in all different majors to achieve the color preferences of students in that major to increase the quality of learning by painting the interior of their classroom according to their own color preferences. Given the effect of culture on the choice of colors, it is suggested that this test be evaluated separately in different cities and countries. Moreover, in another study, it is possible to evaluate the scores of students in classes whose coloring is based on the results of the test on the effect of the educational background, so that the effect of this component will be measured and achieved.

### Further Research

Given the effect of culture on the choice of colors, it is suggested that this test be evaluated separately in different cities and countries. Moreover, in another study, it is possible to evaluate the scores of students in classes whose coloring is based on the results of the test on the effect of the educational background, so that the effect of this component will be measured and achieved.

### References

- Adams, F. M., & Osgood, C. E. (1973). A Cross-Cultural Study of the Affective Meanings of Color. *Journal of Cross-Cultural Psychology*, 4(2), 135–156. <https://doi.org/10.1177/002202217300400201>
- AL-Ayash, A., Kane, R. T., Smith, D., & 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. <https://doi.org/10.1002/col.21949>
- Askarizad, R., Rezaei Liapae, S., & Mohajer, M. (2021). The Role of Sense of Belonging to the Architectural Symbolic Elements on Promoting Social Participation in Students within Educational Settings. *Space Ontology International Journal*, 10(4), 1–10. <https://doi.org/10.22094/SOIJ.2021.1930154.1419>
- Bakker, I., van der Voordt, T., Vink, P., de Boon, J., & Bazley, C. (2015). Color preferences for different topics in connection to personal characteristics. *Color Research & Application*, 40(1), 62–71.
- Bakker, I., Van Der Voordt, T., Vink, P., De Boon, J., & Bazley, C. (2015). Color preferences for different topics in connection to personal characteristics. *Color Research and Application*, 40(1), 62–71. <https://doi.org/10.1002/col.21845>
- Baniani, M., & Yamamoto, S. (2015). A comparative study on correlation between personal background and interior color preference. *Color Research and Application*, 40(4), 416–424. <https://doi.org/10.1002/col.21906>
- Barrett, P., Davies, F., Zhang, Y., & Barrett, L. (2015). The impact of classroom design on pupils' learning: Final results of a holistic, multi-level analysis. *Building and Environment*, 89, 118–133. <https://doi.org/10.1016/j.buildenv.2015.02.013>
- Barrett, P., Zhang, Y., Moffat, J., & Kobbacy, K. (2013). A holistic, multi-level analysis identifying the impact of classroom design on pupils' learning. *Building and Environment*, 59, 678–689. <https://doi.org/10.1016/j.buildenv.2012.09.016>
- Beckers, R., van der Voordt, T., & Dewulf, G. (2016). Learning space preferences of higher education students. *Building and Environment*, 104, 243–252. <https://doi.org/10.1016/j.buildenv.2016.05.013>
- Beke, L., Kutas, G., Kwak, Y., Sung, G. Y., Park, D. S., & Bodrogi, P. (2008). Color preference of aged observers compared to young observers. *Color Research and Application*, 33(5), 381–394. <https://doi.org/10.1002/col.20434>
- Bonnardel, V., Beniwal, S., Dubey, N., Pande, M., & Bimler, D. (2018). Gender difference in color preference across cultures: An archetypal pattern modulated by a female cultural stereotype. *Color Research and Application*, 43(2), 209–223. <https://doi.org/10.1002/col.22188>
- Brooker, A., & Franklin, A. (2016). The effect of colour on children's cognitive performance. *British Journal of Educational Psychology*, 86(2), 241–255. <https://doi.org/10.1111/bjep.12101>
- Brooks, D. C. (2011). Space matters: The impact of formal learning environments on student learning. *British Journal of Educational Technology*, 42(5), 719–726. <https://doi.org/10.1111/j.1467-8535.2010.01098.x>
- Carvalho, L., Nicholson, T., Yeoman, P., & Thibaut, P. (2020). Space matters: framing the New Zealand learning landscape. *Learning Environments Research*, 23(3), 307–329. <https://doi.org/10.1007/s10984-020-09311-4>
- Clarke, T., & Costall, A. (2008). The emotional connotations of color: A qualitative investigation. *Color Research & Application*, 33(5), 406–410. <https://doi.org/10.1002/col.20435>
- Corr, P. J., & Matthews, G. E. (2020). *The Cambridge handbook of personality psychology*. Cambridge University Press.
- Crozier, W. R. (1996). The psychology of colour preferences. *Review of Progress in Coloration and Related Topics*, 26, 63–72. <https://doi.org/10.1111/j.1478-4408.1996.tb00111.x>
- Cubukcu, E., & Kahraman, I. (2008). Hue, saturation, lightness, and building exterior preference: An empirical study in Turkey comparing architects' and nonarchitects' evaluative and cognitive judgments. *Color Research & Application: Endorsed by Inter-Society Color Council, The Colour Group (Great Britain), Canadian Society for Color, Color Science Association of Japan, Dutch Society for the Study of Color, The Swedish Colour Centre Foundation, Colour Soc*, 33(5), 395–405.
- Del Giudice, M. (2012). The Twentieth Century Reversal of Pink-Blue Gender Coding: A Scientific Urban Legend? *Archives of Sexual Behavior*, 41(6), 1321–1323. <https://doi.org/10.1007/s10508-012-0002-z>

- Demir-Yildiz, C., & Tatik, R. S. (2019). Impact of flexible and non-flexible classroom environments on learning of undergraduate students. *European Journal of Educational Research*, 8(4), 1159–1173. <https://doi.org/10.12973/eu-jer.8.4.1159>
- Elliot, A. J., & Maier, M. A. (2014). Color Psychology: Effects of Perceiving Color on Psychological Functioning in Humans. *Annual Review of Psychology*, 65(1), 95–120. <https://doi.org/10.1146/annurev-psych-010213-115035>
- Eynde, P. O. 't, Corte, E. De, & Verschaffel, L. (2006). “Accepting Emotional Complexity”: A Socio-Constructivist Perspective on the Role of Emotions in the Mathematics Classroom. *Educational Studies in Mathematics*, 63(2), 193–207. <https://doi.org/10.1007/s10649-006-9034-4>
- Eysenck, H. J. (1941). A Critical and Experimental Study of Colour Preferences. *The American Journal of Psychology*, 54(3), 385. <https://doi.org/10.2307/1417683>
- Feli, S., Habib, F., & Shahcheraghi, A. (2020). Identification Of Components Affecting Synomorphy And Utilization Of It In Planning Educational Spaces (Case: Faculties Of Art And Architecture Of Tehran). *Space Ontology International Journal*, 9(1968), 43–56. [http://soij.qiau.ac.ir/article\\_680517\\_a54e406d3c80f6d8e546d72026c933ed.pdf](http://soij.qiau.ac.ir/article_680517_a54e406d3c80f6d8e546d72026c933ed.pdf)
- Franke, T. M., Ho, T., & Christie, C. A. (2012). The chi-square test: Often used and more often misinterpreted. *American Journal of Evaluation*, 33(3), 448–458.
- Gabarró-López, S. (2020). Are discourse markers related to age and educational background? A comparative account between two sign languages. *Journal of Pragmatics*, 156, 68–82.
- Gaines, K. S., & Curry, Z. D. (2011). The Inclusive Classroom : The Effects of Color on Learning and Behavior. *Journal of Family & Consumer Sciences Education*, 29(1), 46–57.
- Genschow, O., Reutner, L., & Wänke, M. (2012). The color red reduces snack food and soft drink intake. *Appetite*, 58(2), 699–702. <https://doi.org/10.1016/j.appet.2011.12.023>
- Gottesman, A. A., & Morey, M. R. (2010). CEO educational background and firm financial performance. *Journal of Applied Finance (Formerly Financial Practice and Education)*, 20(2).
- Güneş, E., & Olguntürk, N. (2020). Color-emotion associations in interiors. *Color Research and Application*, 45(1), 129–141. <https://doi.org/10.1002/col.22443>
- Han, H., Kiatkawsin, K., Kim, W., & Hong, J. H. (2018). Physical classroom environment and student satisfaction with courses. *Assessment and Evaluation in Higher Education*, 43(1), 110–125. <https://doi.org/10.1080/02602938.2017.1299855>
- Hanafy, I. M., & Sanad, R. (2015). Colour Preferences According to Educational Background. *Procedia - Social and Behavioral Sciences*, 205(May), 437–444. <https://doi.org/10.1016/j.sbspro.2015.09.034>
- Hao, Q., Barnes, B., & Jing, M. (2021). Quantifying the effects of active learning environments: separating physical learning classrooms from pedagogical approaches. *Learning Environments Research*, 24(1), 109–122. <https://doi.org/10.1007/s10984-020-09320-3>
- Huang, W., & Xu, W. (2009). Interior Color Preference Investigation Using Interactive Genetic Algorithm. *Journal of Asian Architecture and Building Engineering*, 8(2), 439–445. <https://doi.org/10.3130/jaabe.8.439>
- Humburg, M. (2017). Personality and field of study choice in university. *Education Economics*, 25(4), 366–378.
- Humphrey, N. (1971). Colour and brightness preferences in monkeys. *Nature*, 229(5287), 615–617. <https://doi.org/10.1038/229615a0>
- Jackson, J. J. (2011). *The effects of educational experiences on personality trait development*. University of Illinois at Urbana-Champaign.
- Jonauskaitė, D., Dael, N., Chèvre, L., Althaus, B., Tremea, A., Charalambides, L., & Mohr, C. (2019). Pink for Girls, Red for Boys, and Blue for Both Genders: Colour Preferences in Children and Adults. *Sex Roles*, 80(9–10), 630–642. <https://doi.org/10.1007/s11199-018-0955-z>
- Kariippanon, K. E., Cliff, D. P., Lancaster, S. L., Okely, A. D., & Parrish, A. M. (2018). Perceived interplay between flexible learning spaces and teaching, learning and student wellbeing. *Learning Environments Research*, 21(3), 301–320. <https://doi.org/10.1007/s10984-017-9254-9>
- Karimifard, L., & Tabatabaei Malazi, F. (2017). Physical Factors Influencing Place Identity in Higher Education Environments (Case study: Islamic Azad University, South Tehran Branch). *Space Ontology International Journal*, 6(1), 55–68.
- Kuhbandner, C., & Pekrun, R. (2013). Joint effects of emotion and color on memory. *Emotion*, 13(3), 375–379. <https://doi.org/10.1037/a0031821>
- Küller, R., Mikellides, B., & Janssens, J. (2009). Color, arousal, and performance - A comparison of three experiments. *Color Research and Application*, 34(2), 141–152. <https://doi.org/10.1002/col.20476>
- Kurt, S., & Osueke, K. K. (2014). The Effects of Color on the Moods of College Students. *SAGE Open*, 4(1), 215824401452542. <https://doi.org/10.1177/2158244014525423>
- Kusurkar, R., Kruitwagen, C., Ten Cate, O., & Croiset, G. (2010). Effects of age, gender and educational background on strength of motivation for medical school. *Advances in Health Sciences Education*, 15(3), 303–313.
- Loisos, G. (1999). Daylighting in Schools. *Heschong Mahone Group*, 139–145.
- MacMahon, S., Carroll, A., & Gillies, R. M. (2020). Capturing the ‘vibe’: an exploration of the conditions underpinning connected learning environments.

- Learning Environments Research*, 23(3), 379–393.  
<https://doi.org/10.1007/s10984-020-09312-3>
- Madden, T. J., Hewett, K., & Roth, M. S. (2000). Managing Images in Different Cultures: A Cross-National Study of Color Meanings and Preferences. *Journal of International Marketing*, 8(4), 90–107.  
<https://doi.org/10.1509/jimk.8.4.90.19795>
- Maier, M. A., Elliot, A. J., & Lichtenfeld, S. (2008). Mediation of the negative effect of red on intellectual performance. *Personality and Social Psychology Bulletin*, 34(11), 1530–1540.  
<https://doi.org/10.1177/0146167208323104>
- Mäkelä, T., Helfenstein, S., Lerkkanen, M. K., & Poikkeus, A. M. (2018). Student participation in learning environment improvement: analysis of a co-design project in a Finnish upper secondary school. *Learning Environments Research*, 21(1), 19–41.  
<https://doi.org/10.1007/s10984-017-9242-0>
- Mun, S., Han, S. H., & Seo, D. (2020). The impact of CEO educational background on corporate cash holdings and value of excess cash. *Pacific-Basin Finance Journal*, 61, 101339.
- Niesta Kayser, D., Elliot, A. J., & Feltman, R. (2010). Red and romantic behavior in men viewing women. *European Journal of Social Psychology*, 40(6), 901–908. <https://doi.org/10.1002/ejsp.757>
- Pourbagher, S., Azemati, H. R., & Saleh Sedgh Pour, B. (2021). Classroom wall color: a multiple variance analysis on social stress and concentration in learning environments. *International Journal of Educational Management*, 35(1), 189–200.  
<https://doi.org/10.1108/IJEM-06-2020-0282>
- Rahimi, Z., Shirali, G. A., Araban, M., Mohammadi, M. javad, & Cheraghian, B. (2021). Mask use among pedestrians during the Covid-19 pandemic in Southwest Iran: an observational study on 10,440 people. *BMC Public Health*, 21(1), 1–9.  
<https://doi.org/10.1186/s12889-020-10152-2>
- Read, M. A., & Upington, D. (2009). Young children's color preferences in the interior environment. *Early Childhood Education Journal*, 36(6), 491–496.  
<https://doi.org/10.1007/s10643-009-0311-6>
- Rim, K. C., & Yoon, Y. B. (2015). Study of learning performance improvement based on color changes of test sheets. *International Journal of Multimedia and Ubiquitous Engineering*, 10(9), 9–16.  
<https://doi.org/10.14257/ijmue.2015.10.9.02>
- Rowe, A. D., Fitness, J., & Wood, L. N. (2015). University student and lecturer perceptions of positive emotions in learning. *International Journal of Qualitative Studies in Education*, 28(1), 1–20.  
<https://doi.org/10.1080/09518398.2013.847506>
- Roy, R., Soo, D., Conroy, D., Wall, C. R., & Swinburn, B. (2019). Exploring university food environment and on-campus food purchasing behaviors, preferences, and opinions. *Journal of Nutrition Education and Behavior*, 51(7), 865–875.
- Schenke, K., Ruzek, E., Lam, A. C., Karabenick, S. A., & Eccles, J. S. (2017). Heterogeneity of student perceptions of the classroom climate: a latent profile approach. *Learning Environments Research*, 20(3), 289–306. <https://doi.org/10.1007/s10984-017-9235-z>
- Schloss, K. B., Nelson, R., Parker, L., Heck, I. A., & Palmer, S. E. (2017). Seasonal Variations in Color Preference. *Cognitive Science*, 41(6), 1589–1612.  
<https://doi.org/10.1111/cogs.12429>
- Sorokowski, P., Sorokowska, A., & Witzel, C. (2014). Sex differences in color preferences transcend extreme differences in culture and ecology. *Psychonomic Bulletin and Review*, 21(5), 1195–1201.  
<https://doi.org/10.3758/s13423-014-0591-8>
- Taj, S., Fatima, S. A., Imran, S., Lone, A., & Ahmed, Q. (2021). Role of hematological parameters in the stratification of COVID-19 disease severity. *Annals of Medicine and Surgery*, 62, 68–72.
- Taylor, C., Clifford, A., & Franklin, A. (2013). Color preferences are not universal. *Journal of Experimental Psychology: General*, 142(4), 1015–1027. <https://doi.org/10.1037/a0030273>
- Tikka, P. M., Kuitunen, M. T., & Tynys, S. M. (2000). Effects of educational background on students' attitudes, activity levels, and knowledge concerning the environment. *The Journal of Environmental Education*, 31(3), 12–19.
- Tyng, C. M., Amin, H. U., Saad, M. N. M., & Malik, A. S. (2017). The Influences of Emotion on Learning and Memory. *Frontiers in Psychology*, 8(AUG). <https://doi.org/10.3389/fpsyg.2017.01454>
- van der Voordt, T., Bakker, I., & de Boon, J. (2017). Color preferences for four different types of spaces. *Facilities*, 35(3/4), 155–169.  
<https://doi.org/10.1108/F-06-2015-0043>
- Wilms, L., & Oberfeld, D. (2018). Color and emotion: effects of hue, saturation, and brightness. *Psychological Research*, 82(5), 896–914.  
<https://doi.org/10.1007/s00426-017-0880-8>
- Zhang, Y., Liu, P., Han, B., Xiang, Y., & Li, L. (2019). Hue, chroma, and lightness preference in Chinese adults: Age and gender differences. *Color Research and Application*, 44(6), 967–980.  
<https://doi.org/10.1002/col.22426>