The Effect of Color on Learning Efficiency among Primary School Students in Noorabad Delfan, Iran

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Abstract

Background
Learning is a multi-directional process involving many factors, such as teachers, students, characteristics of the learning environment, to attain desired objectives. This study aimed to investigate the color preference of the educational space by teachers and students and its effect on the attitude and learning productivity in primary school students.

Materials and Methods: The research method was a combination of documentary and library studies along with survey research. After the classification of data obtained by the library research, the images of 60 cases were presented to 31 experts, and 15 cases were finally selected and distributed among 212 subjects in Noorabad Delfan, Iran. The samples were selected among 10 classes using the un-purposeful non-probability sampling. The teachers and students answered a researcher-made questionnaire.

Results: There were 106 (50%) male students in this study. Blue and green colors had the highest priority among male and female teachers. Results showed that the preference for red decreased while that for green increased with age. The results of examining the opinions of experts and audiences showed that the color of the classroom also affected the physical and mental health of users of that space, in addition to being a factor of vitality.

Conclusion
The findings indicate that the color priority of the educational space was different in teachers and students, as well as by their gender. Given that the space color affects the mood of the users and the productivity of learning, this issue should be considered besides the connection between indoor and outdoor spaces and the use of educational spaces with a color spectrum that conforms to the users' desires and needs.

Key Words: Color, Educational Ambience, Learning, Primary students.

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1- INTRODUCTION

The school as an architectural body includes components that lead to learning. The environment plays a role in the amount and quality of learning, which takes place consciously and unconsciously. Therefore, learning can be more effective in an illuminated space (so-called airy space) with dimensions and sizes that conform to the age of learners than learning in a dark, cramped, and depressing space. The conditions of many of the existing buildings are not suitable in terms of coloring. This unsuitability can be seen in old buildings colored in gray and brown that decrease the sense of curiosity and enthusiasm in students. The realization of the desired goals may be difficult in schools where the physical space and the environment affecting the psyche of the students cause fatigue, disorder, and lack of concentration (1). The vision that can be considered as the most important means of human communication with the surrounding phenomena occurs through the reflection of color light from the objects (including architectural elements) to the human eye (2).

An efficient school includes valuable educational environments in terms of visual qualities, which can be created through a proper design (3). Moreover, the color and light used in an educational space are among the factors with the highest effect on learning, which should conform to the age and educational level of the students (4). The conformity of the use of space to the color used in architectural elements and equipment can play a special role in increasing the efficiency and effectiveness of the space. Colors cause different physiological responses in terms of blood pressure, heart rate, respiratory rate, gastrointestinal tract function, and body temperature, and may create different sensations in individuals depending on the cultural background (5, 6). Blue light has the greatest effect on the circadian rhythm through its effect on melatonin. This effect has even been observed among blind people (7). White light enhances visual acuity, it causes more accurate perception, better color recognition, and better distinction of the components, increases the concentration of the individual motivational forces on the activity, decreases the fatigue of the sensory-motor organs, and improves the human mood (8). A review of the literature demonstrates that the appropriate color of the space can affect the learning quality of students while affecting the health of the body and the mind of users as well. This issue has been studied from three viewpoints of the environment, architecture, and humans considering five aspects of psychology, student learning, environmental body, motor behavior, and environmental comfort. In some studies, the criteria for the assessment were the scores obtained by students in learning environments with conditions that conform to students' expectations, and the results were obtained mainly by surveys and field studies.

Therefore, considering the sensitive age of elementary school students and the revival of the concept of school as the second home for children, important issues related to the architecture and design of the space body, such as appropriate coloring, should be considered in addition to the layout and structure of the buildings to achieve educational goals. As the present study aimed to investigate the effects of color on the learning of elementary students, its main strategy is the improvement of the color of the space in the classrooms using the simplest design methods. Accordingly, this research tried to examine the color preference of the educational space by teachers and students and the effect of color on creating a positive attitude and learning productivity in primary school students in Noorabad city, Iran.

2- MATERIALS AND METHODS

2.1. Study design and setting

In this cross-sectional study, the library research and the study of valid resources related to the research topic and the relevant theoretical foundations were first used to collect data. After the classification of data obtained by the library research, a total of 60 images were presented to 31 experts in the second step, and 15 cases were finally selected and distributed among 212 subjects in Noorabad Delfan city, Lorestan province, Iran. The justification for using images was that the questions were presented with color images in order for students to have a better understanding of the questions due to their low ages. The students were chosen among 10 classes using simple random sampling and all teachers were included in the study through the census method. In terms of the color preference, 240 students (male and female elementary school students), and 39 teachers (24 females and 15 males) were surveyed in this research.

2-2. Data collection tool

In the first step, the literature was reviewed and the documents (papers, dissertations, and books) related to the research topic were studied to collect data. This search aimed to investigate the effect of educational space color on learning to be considered in the educational space design. In the second step, the students and teachers were surveyed based on, and a questionnaire was used as a source to collect data regarding color priority from the participants. The effect of color on learning productivity was investigated using the obtained results and data.

2-3. Measurement tool

To assess the students' attitudes about the color priority of educational space, a goal-content table was prepared by studying and categorizing previous studies, and a questionnaire containing 15 items was designed according to this table. The validity of the questionnaire was evaluated by measuring face validity, content validity, and construct validity. Face validity was determined using the opinions of experts in the given field. The goal-content table was used to determine the content validity, and factor analysis was used to investigate the construct validity. As mentioned above, a researcher-made questionnaire was used to collect data, and to ensure its validity, it was investigated and confirmed by architecture experts before its distribution among the samples.

The reliability of the questionnaire was confirmed by a Cronbach's alpha of 0.830, indicating a very good internal consistency and reliability. The discrimination index for each question was investigated using the internal correlation between the questions. As a result, 15 questions were identified as appropriate items of the questionnaire. After testing and determining the validity and reliability of the questionnaire, 212 questionnaires in the form of images were distributed among elementary students. Factor analysis was also conducted for the questionnaire containing 15 questions on the Likert scale. After analyzing the factors for the questionnaire, the identified influential reasons of color on learning efficiency of elementary students were psychology (4 questions), learning (4 questions), physical (4 questions), motion behavior (one question), and comfort (2 questions). Teachers and students answered the questions.

2-4. Ethical consideration

This study is a part of a thesis in Master of Arts in Architecture approved by the deputy of the research and technology of our university.

2-5. Data Analysis

Descriptive statistics, including mean, percentage, and range, were used for describing the data. Exploratory data analysis was used to estimate latent factors

or variables and to reduce a large number of variables to a limited set of factors. In other words, this approach seeks to test the correspondence between theoretical and experimental constructs. In this method, the researcher has no initial theory and tries to use factor loadings to discover the factor structure of data (9). The obtained results were analyzed by SPSS software (version 21.0), and LISREL software at a significance level of $< 5\%$.

3- RESULTS

Out of 212 investigated students, 106 individuals were male (50%). In regards to the grade of education, 9, 11.3, 29.2, 23.6, and 26.9% of students were in grades of second, third, fourth, fifth, and sixth, respectively. Attitudes of students about the effect of color on the components of learning productivity in the educational spaces are shown in **Table.1**. In regards to psychological, learning, architectural physics, motion behavior, and environmental comfort, 68, 76.4, 68.9, 80.6, and 30.7% of students respectively expressed the agree or completed agree answers to the effect of colors on these components of learning productivity (**Table.1**).

Table 1: Attitudes of students about the effect of color on the components of learning productivity.

Attitude	Psychological component		Learning component		Architectural physics component		Motion behavior component		Environmental comfort component	
	Frequency	%	Frequency	%	Frequency	%	Frequency	%	Frequency	%
Completely disagree	1	0.5	1	0.5	2	0.9	6	2.8	0	0
Disagree	7	3.3	2	0.9	10	4.7	15	7.1	8	3.8
No opinion	46	21.7	26	12.3	28	13.2	20	9.4	32	15.1
Agree	143	67.5	156	73.6	143	67.5	42	19.8	2	0.9
Completely agree	1	0.5	6	2.8	3	1.4	129	60.8	61	28.8
Total	198	93.4	191	90.1	186	87.7	212	100.0	103	48.6

Table.2 shows the priority of color of the educational space from teachers' opinion. Moreover, the color priority of the educational space from students' opinion is presented in **Table.3**.

Table-2: Priority of color from teachers' opinion of the educational space.

Color Choice	Female teachers		Male teachers	
	Not-choose	Choose	Not-choose	Choose
Red	3	10	6	5
Orange	6	7	7	4
Yellow	7	6	6	5
Green	1	12	1	10
Blue	1	12	1	10
Brown	8	5	7	4
Purple	5	8	5	6
Pink	1	12	2	9
White	9	4	7	4
Black	9	4	9	2
Gray	6	7	9	2

Table-3: Color priority of the educational space from students' opinion.

Color Choice	Female students		Male students	
	Not-choose	Choose	Not-choose	Choose
Red	6	114	5	115
Orange	19	101	16	104
Yellow	8	112	20	100
Green	9	111	21	99
Blue	8	112	12	108
Brown	27	93	32	88
Purple	19	101	38	82
Pink	6	114	36	84
White	43	77	42	78
Black	20	100	42	78
Gray	55	65	42	78

Blue and green colors had the highest priority among male and female teachers, respectively. As such, four male teachers chose the blue color and nine female teachers chose the green color as the preferred colors. The red color was the first choice for both male and female students (**Table.4**).

Table-4: Ranking the priority of colors teacher and student's opinion.

Row	Color	Male Teachers		Female Teachers		Male Students		Female Students	
		1st	2nd	1st	2nd	1st	2nd	1st	2nd
1	Red	-	1	-	1	44	24	44	13
2	Orange	-	-	-	1	1	14	1	8
3	Yellow	-	-	-	2	10	24	8	24
4	Green	3	3	9	1	22	20	16	15
5	Blue	4	3	2	4	27	13	14	14
6	Brown	-	-	-	-	-	2	-	2
7	Purple	1	1	1	1	3	5	7	12
8	Pink	-	2	-	2	5	4	27	27
9	White	3	-	1	-	3	10	3	2
10	Black	-	1	-	-	4	2	-	-
11	Gray	-	-	-	1	1	2	-	1

The results of the investigation of strengths, weaknesses, opportunities, and threats related to the research topic are presented in **Table.5**. **Table.6** shows the results of latent sub-factors that are influenced by the color of the educational space and affect learning productivity.

Table-5: SWOT analysis related to the research topic.

SWOT analysis	Strengths (S)	Weaknesses (W)
Opportunities (O)	1. In the learning process, the school space and components, including doors, walls, and equipment, carry messages. 2. Students' talents can be flourished in different fields of learning by communicating with the surrounding environment, and its effect on the human psyche. 3. The role of the body of educational spaces on the human personality, and challenging students to arouse curiosity and learning.	1. Lack of awareness of the physical and psychological effects of the color of space on students' moods, personalities, and learning. 2. Uniform coloring and lack of conformity with the expectations and needs of the users, causing fatigue, boredom, and lack of concentration of students. 3. Lack of adequate educational facilities and equipment in schools, leading to a lack of motivation. 4. Lack of sufficient financial resources.
Threats (T)	1. Lack of the conformity of the school body with users' expectations. 2. Not applying the opinion of experts and designers and attracting the participation of investors (school-building donors) in the construction and renovation of schools according to the standards. 3. Lack of attention to the attitudes of educational space users (students) by considering the quantitative and qualitative criteria and standards related to space when designing and managing learning spaces.	1. Causing stress, lack of interest, and decreasing learning productivity due to the lack of sufficient facilities and equipment and the physical space that conforms to the expectations of students in terms of coloring, proper lighting, fresh and airy space, etc. 2. Jeopardizing the participation of financial resource providers (school-building donors) if educational productivity does not meet the expectations of parents and educators.

Table-6: Latent sub-factors that are influenced by the color of the educational space and affect learning productivity.

No.	The text of the item measured in the questionnaire
1	Uniform environments that cause anxiety and pleasant environments that encourage the children to be active.
2	The physical space of the school as the second home, which should cause the students to feel affection.
3	The color that conforms to the space use, as well as the functional aspects as factors affecting educational activities and the efficiency of teachers.
4	Using environmental factors and paying attention to the student's desire to achieve satisfaction from the educational environment.
5	The sociability of the environment that is influenced by nature and affects the collective activities of students.

4- DISCUSSION

This study aimed to assess the color preference of educational space by teachers and students and its effect on learning efficiency among children according to the viewpoints of teachers and students. According to our findings, blue and green colors had the highest priority among male and female teachers, respectively, and red color was the first choice for both male and female students. Color as an important visual element of the design in primary schools is recognized to have a direct impact on a child's psychophysiological and behavioral

aspects. Subject preference of student participants revealed that certain colors support specific skills of primary grade children. Blue and orange demonstrated the most favorable impacts on their learning and behavior. Blue was found to enhance the creative artistic skills of children while orange and yellow were identified to support logical thinking associated with mathematics. Green and purple were found to have a balanced impact on improving both logical and creative thinking. Orange and green classes were chosen with a majority of students significantly skilled in learning.

A positive impact of blue color was identified on school attendance. Accordingly, the potential of colors was revealed in creating conducive learning spaces aligned with the learning objectives of primary education (10). The color scheme is an important contributor to students' achievement, as well as to teachers' effectiveness and efficiency. Color can have more impact than cognitive thinking functions; it can also influence affective areas of learning. Color also has a direct link to student behavior. The major underlying color factor that influenced behavior, mood, and learning in the classroom was the color preference.

Four main areas influenced by the color preference were a positive effect on students' interest and attitudes to learning and learning materials, the clear effect of color on behavior, the effect of color on emotions, and the gender differences in the color preference (11). A significant effect of color on children's cognition suggests that the negative effects of red on cognitive performance, which have been documented for adults, are also active in children. The findings suggest that color is not only a visual stimulus for children but it evokes aesthetic responses and can have a subtle influence on the performance in education-related tasks (12). Color impacts student behavior within the physical

learning environment. The three major areas reviewed were (1) an inclusive classroom for students, (2) color theory, and (3) the physiological and psychological aspects of color. The results show that color is important in designing functional learning spaces. The results of this analysis may benefit educators, parents, and design professionals in designing beneficial learning environments for all students (13). Based on the findings of this study, the following suggestions can be offered to increase the productivity of education:

1.   Using the opinion of experts and designers when designing schools (using elements and colors in nature that conform to the age of users and the use of space, lighting, and new educational equipment and technologies).

2.   Creating a fresh and attractive environment for students using warm colors that conforms to the user's desire, as a dynamic and healing factor for life and learning, equipping the classrooms, and providing workshops.

3.   Promoting the participation of users (students) by considering quantitative and qualitative standards in the design and management of educational spaces, leading to motivation, spiritual vitality, and better learning.

4.   Attracting the participation of investors and become acquainted with the effect of space architecture on the learning process and thus on the national growth and development.

No contribution of students to precious answers to the questions and a short time to answer the questions can be considered as the limitations of the study.

5- CONCLUSION

The findings indicate that the color priority of educational space is different in teachers and students, as well as by their

gender. Therefore, this matter should be taken into consideration given that the space color affects the mood of users and the productivity of learning while making a connection between indoor and outdoor spaces and the use of educational spaces with a color spectrum that conforms to the users' desires and needs.

6- ACKNOWLEDGEMENTS

7- CONFLICT OF INTEREST: None.

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