ITU A|Z • Vol 13 No 2 • July 2016 • 73-78

A research on the effect of classroom wall colours on student's attention

Fazıla DUYAN[1], Rengin ÜNVER[2]
[1] faziladuyan@gmail.com • Department of Architecture, Yıldız Technical University, Istanbul, Turkey
[2] runver@yildiz.edu.tr • Department of Architecture, Yıldız Technical University, Istanbul, Turkey

Received: May 2016 • Final Acceptance: July 2016

Abstract
In this study, the effect of classroom wall colours on student's attention was investigated. The research was conducted with the age groups of 8-9 in the two primary schools, one private the other state. These schools have a different socia-cultural and economic scale. A total of 78 students participated in this study. Five colours (5R 7/8, 5Y 7/8, 5G 7/8, 5B 7/8, 5P 7/8) were selected by using Munsell Colour System and classroom walls were painted for five consecutive weeks. The students had lessons under different wall colours and the attention tests were performed on students the end of the weekday. The results show that attention scores were the highest in the purple (5P 7/8) wall colour conditions and the lowest in the red (5R 7/8) wall colour conditions.

Keywords
Attention, Children, Classroom, Student, Wall colour.

doi: 10.5505/itujfa.2016.57441

1. Introduction

Stimulus caused from the physical elements of a space affect peoples' behaviour and attention. These physical elements can be defined as the shape of a space, colour, texture, lighting and sound etc. Likewise, there is also a social factor such as, crowds of people who are difficult to control. Educational buildings and classrooms are one of the environments occupied by large crowds. These kinds of spaces have a significant impact on students' learning outcomes and should ensure that students get the maximum performance. Therefore, analysing interior physical components of classrooms and designing for the purposes of education can contribute significantly to the education system.

Wall colour is one the largest physical components in a classroom and it stimulates students' cognitive responses and affects their behaviour as well. As a matter of fact, the role of the physical environment and also the interior colour of a classroom in regards to helping students' concentrate, has become the subject of the research. In related literature, previous studies which focused on the impact of interior colour have emphasized the relationship between interior space colour and the attention of users (Kwallek, 1996;Küller, 2009;Baytin, 2005). These studies mostly were carried out using adult subjects, not children. People spend a lot of time in a classroom starting from early childhood, childhood, teenage and puberty. This is especially important in the primary school setting where 7-11 year olds are learning and processing information critical information because they are in the concrete-operational stage according to Piaget's cognitive-developmental theory (Park, 2012).

Considering all these factors mentioned above, the stand-out issue is to establish "how classroom wall colour affects attention of students in terms of cognitive responses at the primary school level". Therefore, the aim of the current study was to examine the impact of classroom wall colour on attention of 8-9 aged children. In this context, a field experiment was realized with students from different socio-cultural and economic backgrounds in two elementary schools, one of which was a state school and the other a private school. There were two hypothesizes in the study; firstly, that the attention of students would be affected by different wall colours in a classroom, and secondly, whether socio-cultural and economic scales would affect cognitive responses of students to different wall colours.

2. Method

The aim of the study was to examine the effect of classroom wall colours on students' attention. It was carried out in real classroom of the third grade students 8-9 aged group in two elementary schools, one of which was a state school and the other a private school in Çekmeköy district of Istanbul. State school students' socio-cultural and economic scales are middle-lower class, private school students' are middle-upper class. The steps of the experiment's method are mainly consisted of three parts:

- Determination of classroom wall colours
- Preparation of experimental conditions in the classroom
- Application and evaluation of the attention test

18 girls and 26 boys were recruited from the private school and 21 girls and 13 boys were recruited from the state school, in total 78 (39 girls, 39 boys) students have been participated to the study. Munsell Colour System was used in the study (Munsell, 1971).

2.1. Determination of classroom wall colours

The human eye can distinguish more than 10.000.000 colours. It is important to determine what colours to use in the experiment. It was decided to use a preliminary investigation (survey) with the participating students in which they determined what colour their classroom should be. Therefore, a survey was realized on the wall colour preferences of the students. So, utilizing users' classroom wall colour preferences was enabled in the experiment (Duyan, 2015).

74 more students were added to participate in the survey alongside

(a) (b) (c)

Figure 1. *Wall colour preference survey.*

the experimental group. In total 152 (74 girls, 78 boys) students, there was 71 students (33 girls, 38 boys) were recruited from private school, 81 students (41 girls, 40 boys) were recruited from state school have participated to the survey. Based on Munsell Colour System, 94 colours were selected and prepared as small samples on grey cartons (Munsell, 1971). The survey was carried out in a real classrooms setting. All subjects were tested for colour vision deficiencies prior to survey using an Ishihara Plate and passed the colour vision deficiencies test (Ishihara, 1990). The survey was realized and the data was gathered. Every subject spent 15-20 minutes on the survey. In order to prevent simultaneous colour contrast with colour samples, desks were wrapped with matt medium grey clothes (Figure 1).

The results of survey were analysed in terms of colour elements such as hue, value and saturation. The results of the survey are given in Figure 2. The results were as follows:

Hue: Trend of hue preferences was not clear as seen in Figure 2. Due to some limitations in implementation, the colours that would be used in the experiment were limited to 5 hues (Red 5R, Yellow 5Y, Green 5G, Blue 5B, Purple 5P) that follow each other in equal steps in Munsell Colour System.

Value: Wall colour trends of students in terms of value leant towards dark medium colours. In this context, the value of colours applied to classrooms was decided to be "7" considering limitations of inner surface reflectance (r) in "TS EN 12464-1: Light and lighting- Lighting of work places – Part 1: Indoor work places" (TS EN 12464-1, 2012).

Saturation: Wall colour preference survey results leant towards higher saturations. Colours used on larger surfaces of enclosed spaces are known to cause colour interactions by inter-reflected light which leads to colour shifts. In order to reduce colour shifts as much as possible and to comply with students' preferences, the saturation of colours was decided to be "8".

In conclusion, 5 colour hues were

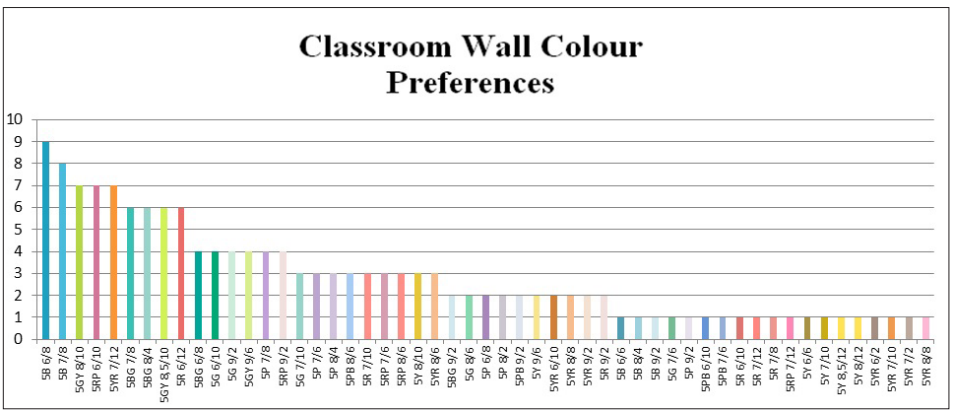

Figure 2. *Private and state school students wall preferences.*

determined, value and saturation remained constant. Munsell Colour System Notations of determined colours are shown in Table 1.

2.2. Preparation of experimental conditions in the classroom

As it is known, all surfaces (ceiling, wall, and floor) and equipment (table, desk, chair etc.) in a closed space are in the visual field of an observer. The location of the observer influences their colour perception. The main objective of the study was to investigate the effect of classroom wall colour on students' attention. Therefore, in order to avoid the colour of classroom equipment affecting the classroom wall colour perception, benches and panels hung on the walls were wrapped with dark medium grey (N 5/0), clothes and classroom cabinets covered with craft papers and pvc of the same colour. Ceilings were painted white (N 8/0). There were no changes to boards, curtains and floors because they were neutral or near to neutral colours. Images such as maps, texts and pictures hung on the wall were mostly removed because they would effect the perception of the wall colour; the compulsory required images for education were left on the walls.

Artificial lighting of all classrooms provided by the luminaries having fluorescent lamps (*Tc*: 6500 K; Ra: 75) on the ceiling. The average artificial illuminance on the desks already existing before the experiment were 250 lm/m^2 in the private school's classroom and 230 lm/m^2 in the state school's classroom. Existing lighting conditions didn't follow standards of TS EN 12464-1 that are operative in Turkey (TS EN 12464-1, 2011). Consequently, existing luminaires were kept, fluorescent lamps were changed (*Tc*: 4000 K; Ra>80) and was ensured that there were 500 lm/ m^2 average artificial illuminance on the desks. In this study, both natural and artificial light were used during the experiment. The sample pictures from re-arranged classrooms are shown in Figure 3.

Table 1. *Munsell colour system notations for classroom walls.*

Colour	Hue	Value/ Saturation	Sample of Wall Colour
RED	5R (5)	7/8	
YELLOW	5Y (25)	7/8	
GREEN	5G (45)	7/8	
BLUE	5B (65)	7/8	
PURPLE	5P (85)	7/8	

2.3. Application and evaluation of the attention test

It was intended to use an attention test which students could understand easily and that would not take much time in order to determinate the effect of attention in terms of cognitive response to classroom wall colour. Bourdon Attention Test, developed by Benjamin Bourdon (1955) was used in the study. The test was composed of 20 lines with 22 letters in each line, in total there are 440 letters. Students were asked to find "b, d, g and p" and mark them in the test in 2 minutes. In order to avoid student getting used to the test, the sequence of the letters were changed every week. The test was evaluated using the hundreds system. The correct letters were calculated in ratio to the total number of correct letters.

The five colours shown in Table 1 were applied to the classrooms during the weekends and students attended their classes for the duration of the week. Bourdon Attention Test was given to students on the last day of the week (Friday). The test was carried out for 5 weeks, a new colour each week (Figure 4).

(a) *(b)* *(c)* *(d)* *(e)*

Figure 3. *Re-arranged classrooms.*

Figure 4. *Application of attention tests.*

3. Results

A Statistical Analysis System was utilized in the evaluation of the received data concerning of the study. The results of the students attention in different wall colour settings was analysed using the "test retest reliability" statistical method. This procedure was carried out for all wall colours in the experiments. For all analyses, the criteria for significance were set at $p < 0.05$ except green wall colour. Average arithmetic scores of Bourdon Attention Test are given in Table 2 and Figure 5-7.

4. Conclusion

In order to determine cognitive responses of 8-9 years old students, five different colours were applied to classrooms each week consecutively and an attention test was conducted each week. Collected data was evaluated by school (private and state) and by sum of both schools and students. Results could be summarized as follows:

- Considering both schools, attention scores of schools were the highest for Purple (5P 7/8) wall colour conditions. Respectively, Purple was followed by Blue (5B 7/8), Green (5G 7/8), Yellow (5Y 7/8) and Red (5R 7/8) wall colours.
- Attention scores for Purple (5P 7/8), Blue (5B 7/8) and Green (5G 7/8) wall colours were in order of 74.67, 72.77 ve 71.73 and the scores were very close to each other. This result can be interpreted that these cool wall colours affect attention of student at the same level.
- Attention scores was the lowest for Red (5R 7/8) wall colour conditions. This result revealed that Red wall colour affected students' attention negatively.
- Private school students scored 23% higher for red wall colour, 8% higher for yellow colour, 8% higher for Green wall colour, 13% higher for Blue wall colour and 13% higher for Purple wall colour than the state school students. It can be observed that even though results varied according to wall colours, the private school students scored higher in every test in comparison to state school students. In other words,

Table 2. *Private and state school attention test scores.*

WALL COLOURS	Week	State School	Private School	State+Private School
RED (5R 7/8)	1.Week	51,85	64,15	58,00
YELLOW (5Y 7/8)	2.Week	62,27	67,29	64,78
GREEN (5G 7/8)	3.Week	68,86	74,60	71,73
BLUE (5B 7/8)	4.Week	68,13	77,41	72,77
PURPLE (5P 7/8)	5.Week	70,70	78,63	74,67

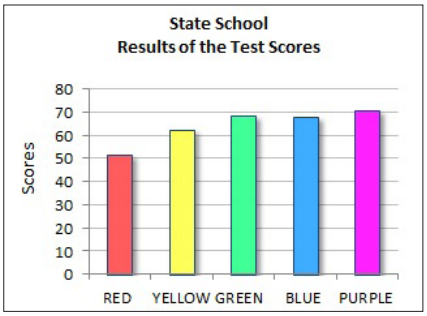

Figure 5. *Attention test results of state school.*

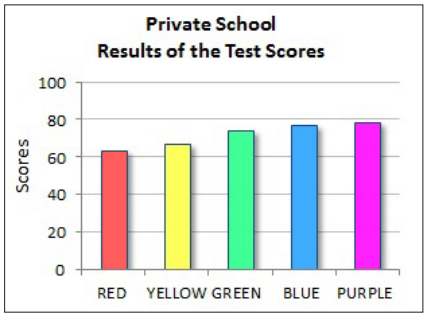

Figure 6. *Attention test results of private school.*

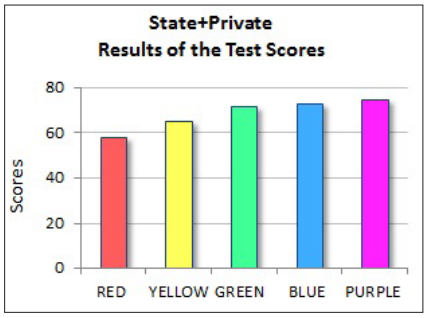

Figure 7. *Attention test results of private and state school.*

private school students are more attentive than state school students. However this situation showed that the ranking of colours effect on student attention. In both groups (state and private) Purple was the highest colour score and Red the lowest. Therefore, this means that socio-culture and economic scale differences don't have influence on classroom wall colour and attention level of students.

These kinds of studies can contribute significantly to educational learning systems as well as education design attributes that will benefit the performance of students. To research relationships between different aged users and a wider spectrum of wall colours can improve users' quality of life.

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