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Learning Improvement of Elementary Students with Lighting Educational Environment

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Abstract- Learning is a multifaceted process that several factors contribute to achieving the desired goals including the teacher, the student and the physical-spatial characteristics. One of the influential factors in modern education is the principled and efficient design of the body of architecture and construction of the educational space. In addition to having a spiritual and metaphysical quality, light is one of the most important factors affecting the body, mind and eyes of students. In order to achieve education, an efficient school, has valuable educational environments in terms of visual qualities, and these visual qualities are possible through proper design, including lighting, transparency, attention to the user's wishes and needs. The aim of this article is to investigate the amount and manner of lighting educational spaces and its effect on learning from the perspective of elementary school students from five dimensions: psychological, learning, architectural body, motor behavior and environmental comfort. Research method, documentary and library method and survey with a sampling volume of 212 items, researcher-made questionnaire and causal relationship modeling by path analysis, direct and indirect effects of physical variables are examined in the educational space from the students' perspectives. The statistical population of this study includes students of elementary schools for girls and boys in the first and second years of Noorabad Delfan city, which was randomly and non-purposefully selected from 10 classrooms to prepare a questionnaire. The results of the questionnaire were calculated after the preparation stage, its validity and reliability and the results were calculated using Spss22 statistical analysis software as α = 0.877. The research findings indicate that by receiving appropriate daylight, the physical, psychological and visual effects of the primary school users under study, the adverse effects of learning have been reduced. As a result, with the help of daylight, the learning productivity of these students has been significantly improved.

Keywords: Learning Productivity, Elementary Student, Educational Environment, Application of Daylight

I. Introduction

Learning is a multifaceted process in which many factors, including the teacher, the student, the physical space characteristics, the new technologies and the physical equipment, contribute to achieving the desired goals. If the environment in which the learner is located is rich, the learner will be successful in achieving the goals of education by being in new situations in terms of the physical characteristics of the space and most importantly, daylight and color appropriate to the use of space and the expectations of users that have a significant impact on the human body and mind, new technologies and physical equipment, communication with peers and teacher training. One of the most important factors that form the basis of children's educational space design with the approach of improving learning in the shadow of body and soul comfort by using natural factors (appropriate light and color), is the relationship between indoor and outdoor space, using the maximum natural light of day, with the help of proper orientation of the space according to the climate of the region. Also, if necessary, rotate the space and create various openings (from the ceiling or walls) by using the space, creating a visual view with the help of transparent bodies, multi-purpose spaces using various and flexible forms, suitable color, floor covering and furniture arrangement. Therefore, the physical atmosphere of the school in educational system should play such a role that it leads to the vitality, dynamism, tranquility and quality of educational activities of students. In this study, after stating the problem (method and amount of receiving appropriate daylight in the classroom in primary schools of Nurabad Delfan city) with library studies, review the research literature and with the help of SPSS 1, Excel 2, and LISREL 3 data, the results of the questionnaire were analyzed by experts and audiences (students) in two ways: exploratory and confirmatory analysis, and the results were obtained based on the Scree Plot curve. In addition to being the most important factor to see and affect the physical and mental health of space users, daylight as an independent variable, affects the educational environment on factors such as non-uniformity, daylight dynamics, sociability, environmental body and attention to user demand as hidden variables, in learning productivity.

II. Statement of the Problem

Since the educational system is one of the most important necessities of any civilization, what has attracted the attention of developed countries today is the discussion on how to design school spaces in consistent

with new educational styles that ultimately lead to the development of effective and efficient people in the community. School is one of the most important buildings in which generations of students grow and their personalities are formed. The school is like an architectural body, with social conditions and the expression of various ideas that lead to students' learning. There are a lot of documents and evidences (existing buildings) that many of them are not in good conditions in terms of color, lighting, access, and active corridors. This disadvantage includes old buildings that are painted with inadequate lighting, the dimensions of the skylight that are painted in gray as a neutral color and takes away the students' curiosity and enthusiasm. If the physical atmosphere of the school and the environment governing the spirit of the students cause fatigue and lack of concentration, the realization of the desired goals will be difficult [1]. Therefore, considering the sensitive age of elementary school students and the revival of the concept "school is the second home of children", it is necessary to address the important issues of architecture and body and space design, including transparency, while solving the problems of location and building structures.

The requirement of the teaching-learning process is to modify and update the methods of education with emphasis on active, group and creative methods which it will be accomplished due to the fresh environment and atmosphere, affected by lightning, coloring, and creating a space for pauses and movements. Given the existing space of schools, creating an attractive educational space for elementary school students to motivate them and providing a learning environment that is influenced by environments with a fresh and transparent physical space, with appropriate lighting and based on the vision of the document of fundamental change is necessary. The physical atmosphere of the schools that shape the personality of the students and the main and future assets of the country should be designed in a way that meets the needs and facilitates the process of achieving the goals and ideals of education and upbringing.

Considering that the aim of the present study is to investigate the effects of natural light on the learning of elementary students, the main strategy is to improve the distribution of daylight in the classroom. Therefore, this study deals with the effect of orientation of educational spaces and how lighting is on the distribution of daylight and other aspects of indoor environments in primary schools by measuring the learning and vitality of students.

The main issue of the research is whether the effective angles of daylight and natural light of the educational space improve the learning process of elementary students?

III. Literature Review

Many researches have been done on the environment and natural elements and their effects on the mood and behavior of educational environments' users. However, the discussion about the body of educational space with the category of lighting, in order to increase the productivity of learning, is a topic that is intended to be addressed in this research. In this research, to show the role of light on learning, the physical effects of light, light quality and brightness, environmental comfort affected by natural light, light color, and the use of light in educational space are considered. Therefore, it is necessary to further introduce these elements that have been considered in the qualitative and quantitative study.

3.1. Physical Effects of Light on Humans

Sight is perhaps the most important means of communication between man and the communication phenomena around him through the reflection of light from objects (including architecture). The ultraviolet rays of daylight prevent bone softening, keep the skin healthy and help the body absorb calcium through the production of vitamin D. Recent researches show that the receptive organs of the human body, each of which responds to a specific stimulus (ear to mechanical stimulus, tongue to chemical stimulus, skin to thermal stimulus, and eyes to optical stimuli) at the same time can also be sensitive to some other stimuli. For example, parts of the skin such as the back of the knees, the back of the elbows, the forehead, and the wrists are able to sense radiant light (even if it is not accompanied by heat) [2]. Lighting is an important and modifiable physical factor in the workplace, which plays a role in maintaining human health and preventing accidents and increasing work efficiency [3].

3.2. Natural Light Quality

Light is a quality that is perceived by the sense of sight and through which objects are seen. Human visual perception is a function of the varying degrees of light and darkness of the environment, and these degrees of light affect his or her physiological reactions. Adequate lighting in educational buildings, plays a role in their physical and mental health as well as being effective on users' behavioral activities. On the contrary, the unfavorable light of the space causes a feeling of discouragement and escape from the space and

disrupts the human nervous system. The researchers studied the effect of classroom light on stress hormones, classroom performance, body growth and health of 88 eight- to nine-year-old students for one year. The results showed that the lack of natural and artificial light has a significant effect on increasing stress hormones [4]. An efficient school has valuable educational environments in terms of visual qualities and through proper design the creation of these visual qualities is possible [5]. Color and light used in the educational environment are the most influential factors in learning that should be appropriate to the age and educational level of the students [6]. Seasonal mood disorder is one of the cases that is directly related to sun exposure [7].

3.3. Ambient Comfort Natural Light

Lack of light will cause non-selection of eyeball disorders, headache, eye irritation and also changes in the spine due to students approaching the paper to compensate for the lack of light and better reading of the book [8]. Providing optimal lighting in the workplace, in addition to maintaining visual health, plays a role in providing visual ergonomics and increases quality and efficiency [9]. Good vision requires enough light and lack or excess of it can cause various disorders such as eye fatigue, headache, visual impairment, blurred vision, physical fatigue and psychological effects. Proper lighting creates focus, motivation and accuracy of users [10].

3.4. Daylight in the Educational Space

In most educational spaces, the main elements of lighting are the windows, which are usually on the same level as the wall and throughout the classroom, and are the main factors in communicating with the environment. The results of the Hatchong Mahon Group, 1999 show that in one year, students who are mostly in the classroom with natural light are about 20% faster in math exams and 26% faster in reading exams than students who are less in an environment with natural light study [11]. In classes where there is not enough daylight, students' blood melatonin levels are much higher than in well-lit classes. This factor causes drowsiness and impairs their performance [12]. Proper use of natural light leads to increased focus in the classroom, reduces noise and increases the efficiency of education and improves the quality of learning in schools [13]. In a study in three American schools, on a large number of students, the effect of different daylight conditions on students' performance showed that there was a significant difference in the scores of the standard and identical tests, so that bright classrooms with large windows and skylights performed much better [14].

3.5. Educational Space Light Color

Blue light has the greatest effect on circadian rhythms through its effect on melatonin, which they even observed this in blind people [15] . White light increases visual acuity, more accurate perception, better color recognition, and cleaner components. It also, increases the focus of motivational forces on activity, and reduces fatigue of the sensorimotor organs and improves human's mood [16].

Therefore, based on studies on the literature and research review, it indicates that the effect of daylight in addition to the health of the body and soul of users, can affect the quality of students learning in three aspects of environment, architecture and human. They have been studied in five specific components of psychological, inclusive learning, environmental body, motor behavior and environmental comfort. Assessment criteria in some studies has been the number of scores obtained by students in learning environments in accordance with students' expectations and the findings of many studies based on surveys and field studies. This is shown in Figure 1 below:

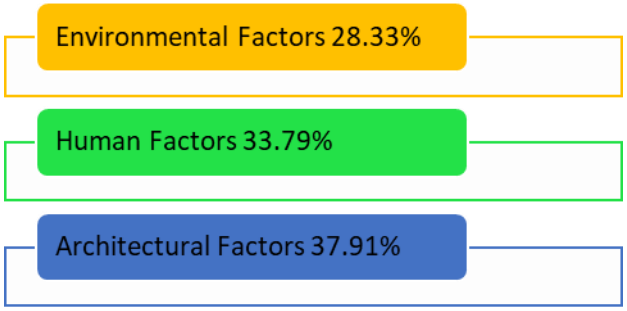


Figure 1. The Effect of Natural Light in Three Areas of Human, Environment and Architecture (Source: Authors)

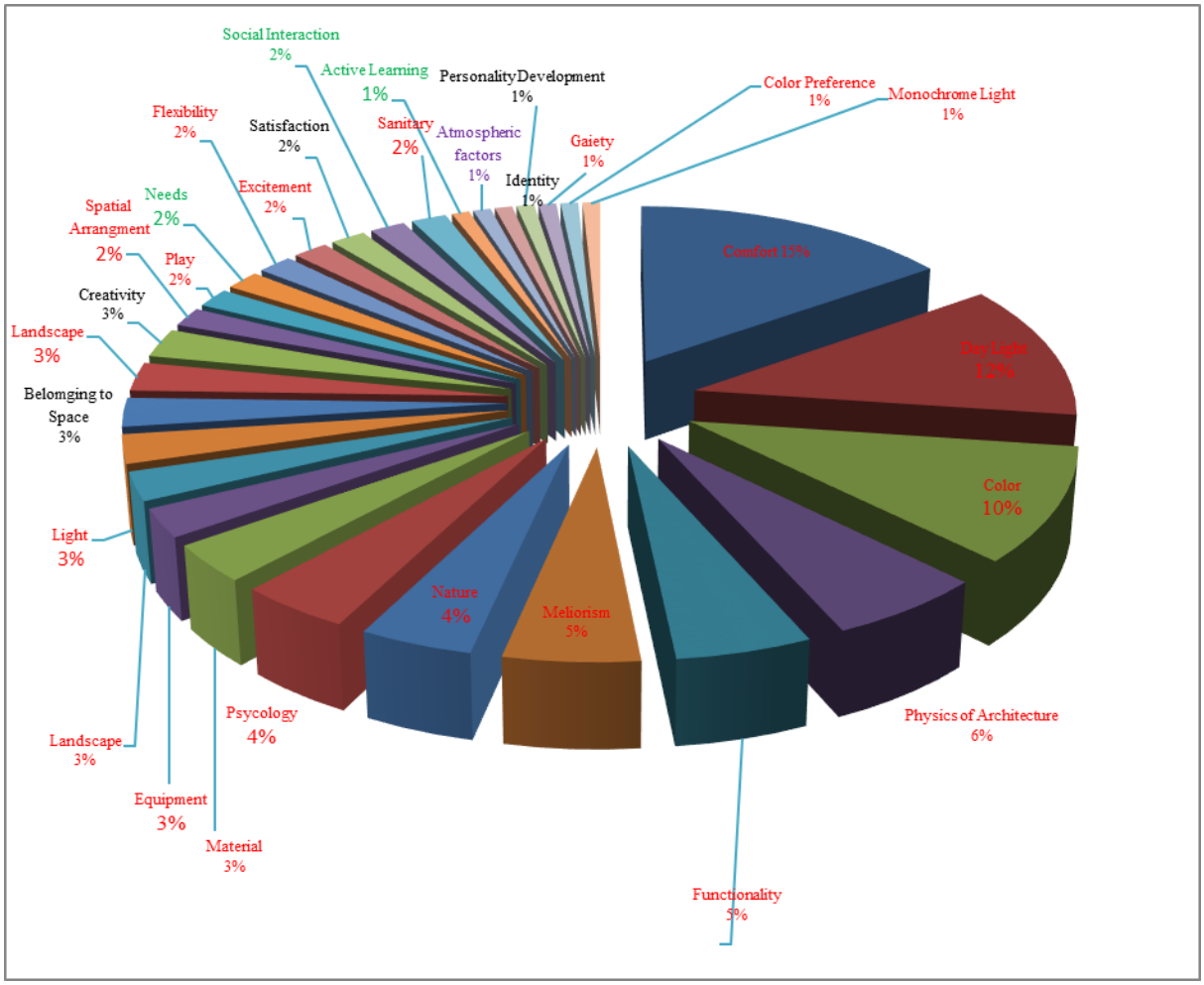


Figure 2. Factors Affected by Natural Light in Educational Space (Source: Authors)

IV. METHODOLOGY

The present study is applied in terms of purpose, and is quantitatively-qualitative in terms of nature. In quantitative research, data collection and analysis are based on mathematical formulas and models, but in qualitative research, information is obtained based on natural evidence and real experience.

Statistical population and data collection: In the first stage, the information was collected from the library method using reliable sources related to the research topic and its theoretical foundations. With a systematic structure based on the study of different areas of related sciences as research and focus on common areas of these areas, categorization was done to achieve the desired goals. Then, in the second stage, after completing the classification of library information, 70 statements were analyzed among these propositions, 60 selected propositions were given to 31 specialized experts, and at the end, 30 propositions were distributed in the form of images in the city of Noorabad, Delfan, and were answered by 212 people (male and female elementary students). The results of this research were analyzed by SPSS, Excel and Lisrel software and the extracted information was analyzed and presented in a descriptive and graphical form.

4.1. Data Collection Tool

In this study, the required information was collected in two steps. Step 1: To gather information over the subject literature; The study of documents (articles, dissertations and books) related to the research topic has been done. Second stage: The attitude of the students of the sample community was based on the research of the survey method and the questionnaire was a very important source in collecting information about the study group. Using the results and information obtained, the effect of light on learning productivity has been judged.

4.2. Measuring Tool

In order to assess the students' point of view, the researcher has compiled a goal-content table by studying and categorizing previous studies, and according to this table, has designed a questionnaire containing 30 statements (measures).

4.3. Questionnaire Validity

In order to evaluate the validity of the questionnaire, three methods of Face validity, Content validity and Structural validity have been used. Formal validity has been determined using the opinion of experts and professors in the field, in order to estimate the content validity of the objective-content table and the construct validity has also been studied using factor analysis. A researcher-made questionnaire was used to collect information and to ensure its validity, it was distributed among the samples after the questionnaire was seen and approved by the professors of architecture.

4.4. Questionnaire Reliability

The reliability of the questionnaire was obtained using Cronbach's alpha method of 0.7877 which shows the internal consistency and very good reliability for this tool. Using the internal correlation methods between the questions, the coefficient Distinctions of each question were studied. As a result, 30 questions were identified as appropriate statements of the questionnaire. After testing and determining the validity and reliability of the questionnaire, 212 questionnaires were distributed in the form of images among elementary students. Factor analysis for the 30-item questionnaire with a Likert scale of 8 was performed and after analyzing the factors for the questionnaire, the factors in Table 1 were identified as follows;

Table 1. Factors Affected by Daylight in the Learning Productivity of Elementary Students (Source: Authors)

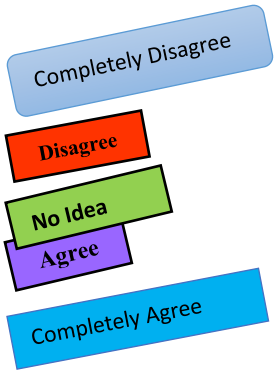
Row	Variable	Percentage of importance	Number of statements	Number of Questions
1	Psychological	20.00%	1,2,3,4,6,7	
2	Learning	26.66%	8,9,10,11,12,13,14,15	
3	Body	16.66%	5,16,19,21,26	
4	Movement behavior	10.00%	17,24,25	
5	Comfort	26.66%	18,20,22,23,27,28,29,30	
Sum of percentages		100.00%	----------	

V. Results and Discussion

5.1. Experts' Views on the Effect of Light on Learning Productivity

To obtain the effect of daylight on students' learning productivity in the educational environment, based on descriptive statistics, one-sample t-test, Scree-plot curve and Kolmogorov-Smirnov test were extracted according to Figure 3.

Guide of graphs:



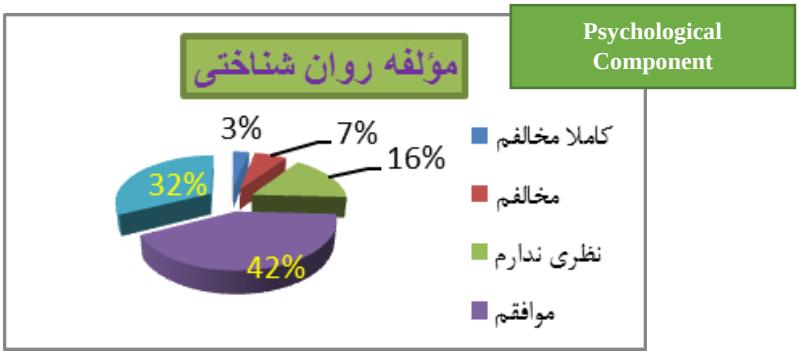


Figure 3. Descriptive Statistics of the Psychological Component (Source: Authors)

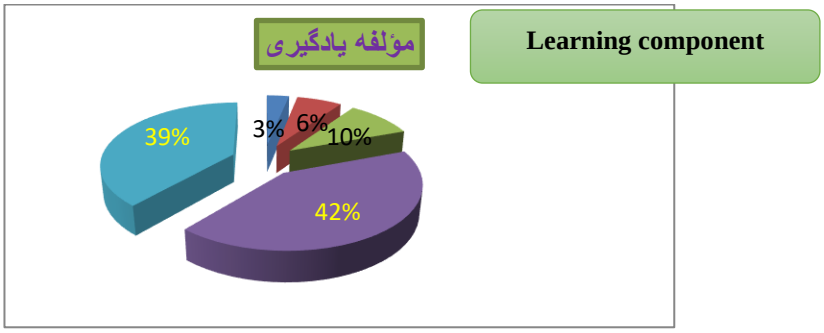


Figure 4. Descriptive Statistics of Learning Component (Source: Authors)

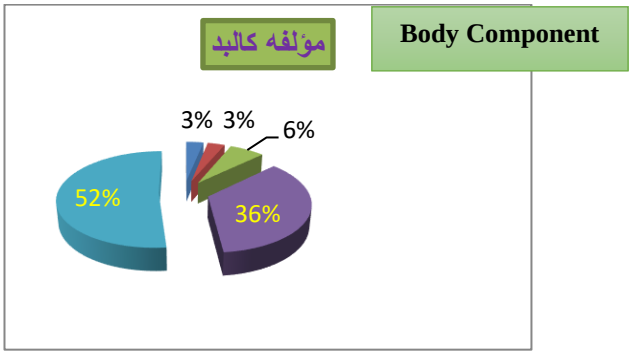


Figure 5. Descriptive Statistics of the Body Component (Source: Authors)

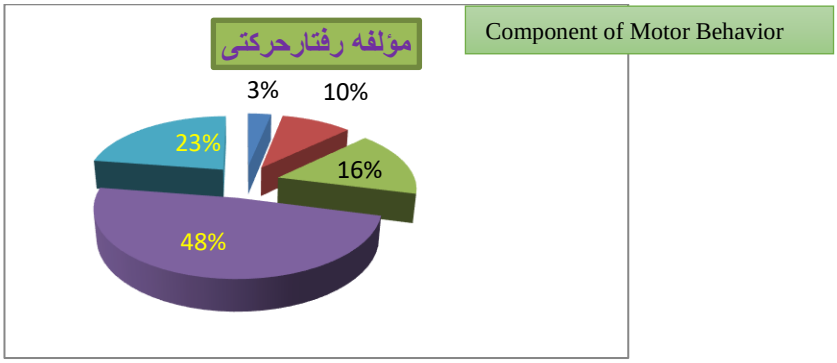


Figure 6. Descriptive Statistics of Motor Behavior Component (Source: Authors)

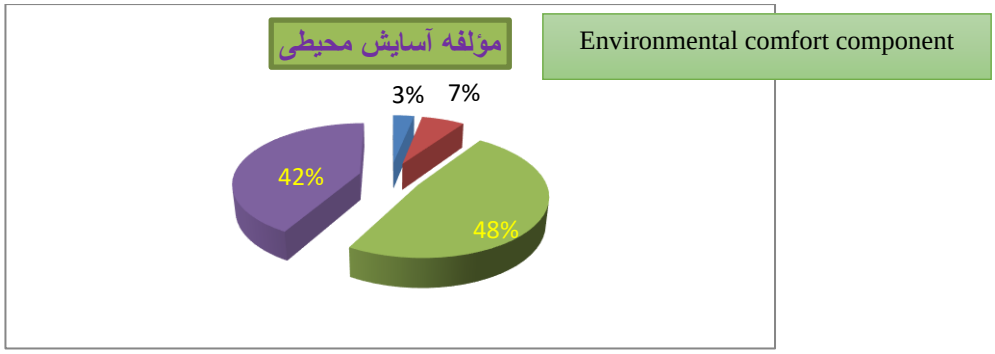


Figure 7. Descriptive Statistics of Environmental Comfort Component (Source: Authors)

Exploratory statistical analysis is a statistical technique used to estimate hidden (hidden) factors or variables and reduce a large number of variables to a smaller number of factors. In other words, the researcher seeks to test the correspondence between theoretical and experimental structures. In this method, the researcher has no initial theory and tries to use factor loads to discover the factor structure of the data [17].

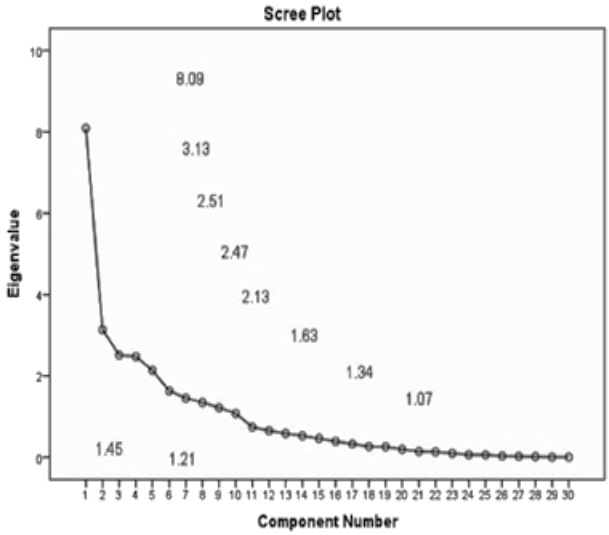


Figure 8. Scree-Plot Curve (Source: Authors)

Table 2. Factors Affecting Learning Productivity, Based on The Script Plot Test of The Expert Community (Source: Authors).

Total Variance Explained					
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings	
	Total	% of Variance	Cumulative %	Total	% of Variance
1	8.090	26.966	26.966	8.090	26.966
2	3.136	10.454	37.419	3.136	10.454
3	2.513	8.375	45.795	2.513	8.375

4	2.475	8.250	54.045	2.475	8.250
5	2.137	7.122	61.167	2.137	7.122
6	1.632	5.442	66.608	1.632	5.442
7	1.452	4.840	71.448	1.452	4.840
8	1.346	4.486	75.934	1.346	4.486
9	1.216	4.053	79.987	1.216	4.053
10	1.075	3.583	83.570	1.075	3.583

5.2 Audience Views on the Effect of Light on Learning Productivity

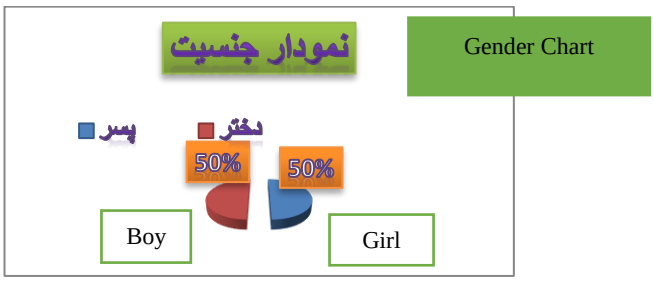


Figure 9. Audience Gender Statistics (Source: Authors)

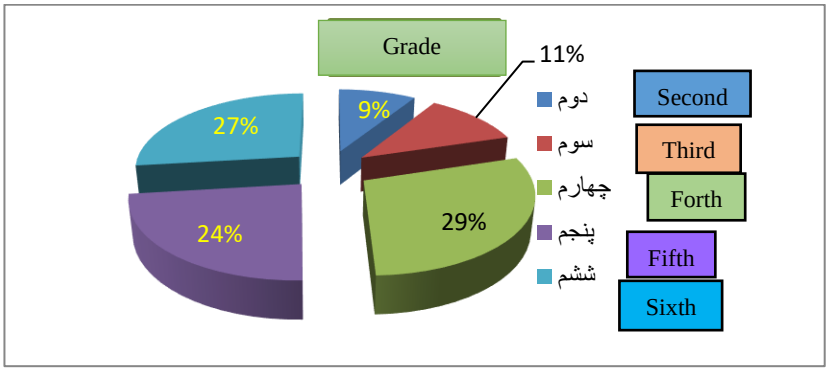


Figure 10. Basic Education Statistics (Source: Authors)

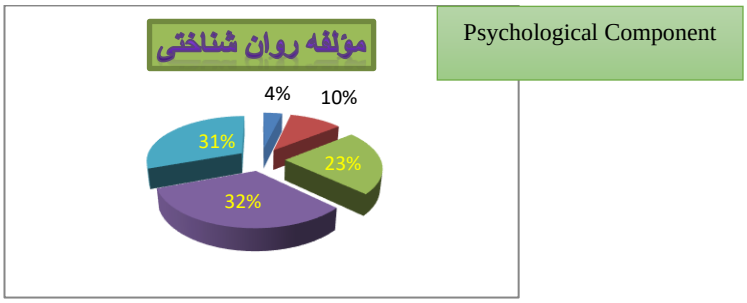


Figure 11. Statistics of the Psychological Component (Source: Authors)

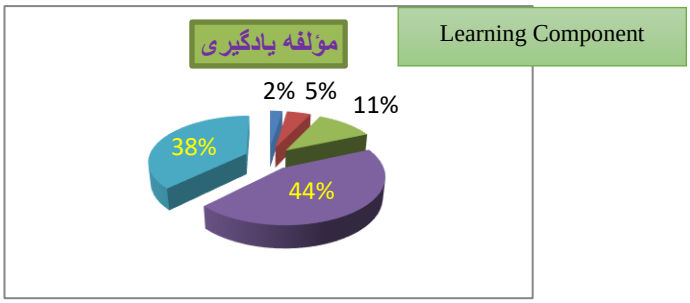


Figure 12. Learning Component Statistics (Source: Authors)

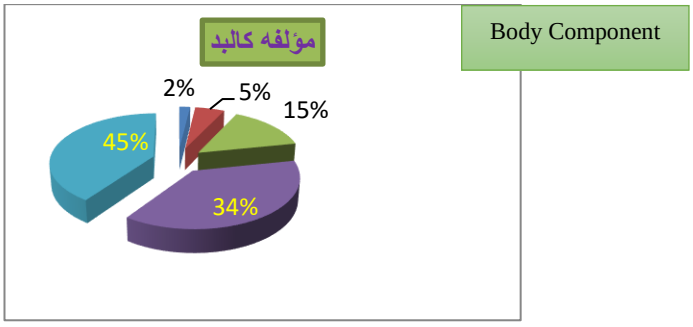


Figure 13. Statistics of the Environmental Body Component (Source: Authors)

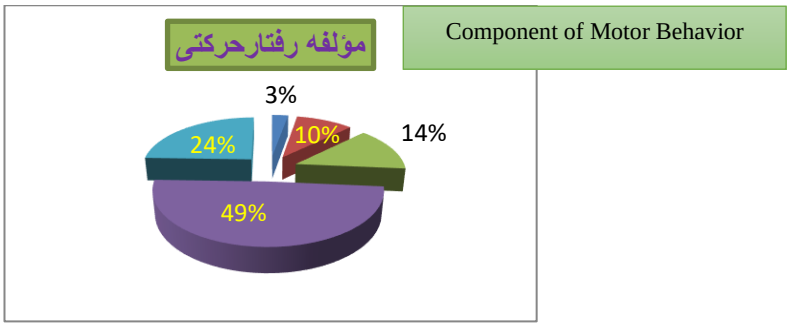


Figure 14. Statistics of Motor Behavior Component (Source: Authors)

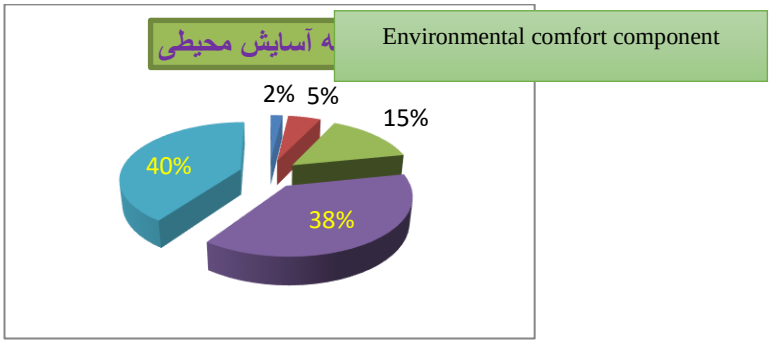


Figure 15. Statistics of Environmental Comfort Component (Source: Authors)

Table 3. Normal Distribution of Data Based on Kolmogorov-Smirnov Test (Source: Authors)

Row	Index variables	Statistics	significance level
1	Psychological Dimension	0.219	0.00
2	Learning	0.275	0.00
3	Body	0.275	0.00
4	Movement Behavior	0.305	0.00
5	Environmental Comfort	0.243	0.00

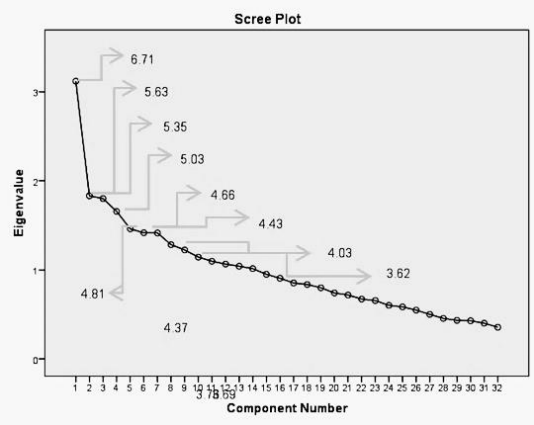


Figure 16. Scree-plot Curve (Source: Authors)

Table 4. Factors Affecting the Learning Productivity of Screen Plot Test, Statistical Population of the Audience (Source: Authors).

Total Variance Explained					
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings	
	Total	% Variance	Cumulative %	Total	% of Variance
1	2.013	6.710	6.710	2.013	6.710
2	1.691	5.636	12.346	1.691	5.636
3	1.607	5.356	17.702	1.607	5.356
4	1.510	5.034	22.736	1.510	5.034
5	1.443	4.811	27.547	1.443	4.811
6	1.400	4.668	32.215	1.400	4.668
7	1.329	4.431	36.646	1.329	4.431
8	1.313	4.376	41.022	1.313	4.376
9	1.211	4.036	45.058	1.211	4.036
10	1.129	3.762	48.821	1.129	3.762
11	1.109	3.698	52.519	1.109	3.698
12	1.087	3.624	56.142	1.087	3.624
13	1.062	3.540	59.682	1.062	3.540

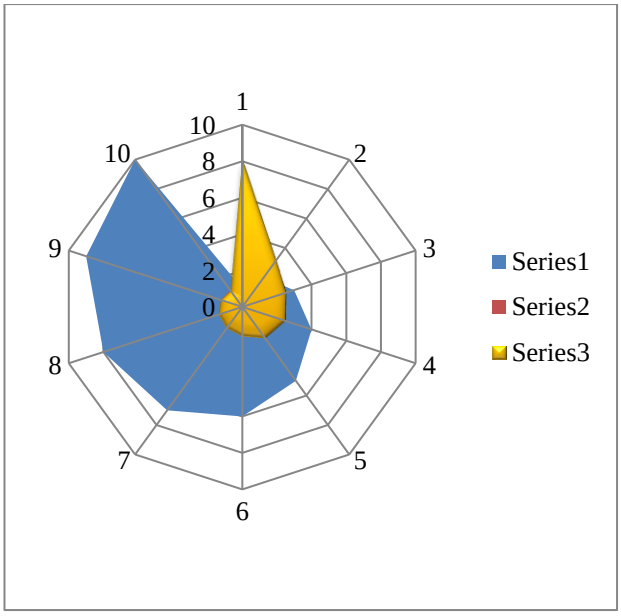


Figure 17. Adaptation Coefficient of 10 Design Criteria (Source: Authors).

Table 5. Factors Affecting Learning Productivity from the Perspective of Experts and Audiences: Scree-Plot Curve (Source: Authors)

Row	Design factors	Experts	Audiences	Common
1	Lack of Uniformity of Environment	✓	✓	✓
2	Landscape Quality		✓	
3	Providing Light and Health	✓		
4	Visual Quality and Comfort	✓		
5	Space Optimization	✓		
6	the Psychological Effect of Light		✓	
7	The Richness of the Environment	✓		
8	User Satisfaction	✓	✓	✓
9	Color Matching with Age		✓	
10	Environmental Sociability	✓	✓	✓
11	Peripheral Body	✓	✓	✓
12	Game Learning Strategy		✓	
13	Adjust Light and Comfort		✓	
14	Flexibility	✓		
15	Daylight Dynamics	✓	✓	✓

Based on the qualitative analysis in Table 6 (SWAT), the solution that can be provided to increase the productivity of education is:

1- Using elements and colors in nature in accordance with the age and use of space, lighting and new educational technologies

2- Creating a fresh and worthy environment for students by using the sunlight, as a dynamic factor

3- Motivating, inspiring students by providing quantitative and qualitative standards for designing and managing educational spaces

4- Attracting the participation of investors and getting acquainted with the effect of space architecture on the learning process and consequently on national growth and development

Table 6. Results of the Study of Strengths and Weaknesses, the Number of Opportunities and Threats (Source: Authors)

(SWOT)	(S) Strengths	(W) weaknesses
Opportunities (O)	1. In the learning process, the classroom, space and elements of the school include doors, walls and equipment are carrying the message. 2. Students' aptitude for different types of learning through communication with natural elements (especially natural light) and the effect of these factors on the human psyche 3. The role of the body of educational spaces on the structure of human personality and challenging students to arouse curiosity and learning. 4. Students' ability to learn from birth and continue in school through connection with nature and attention to this sequence can be considered.	1. Lack of awareness of those in charge of education about the physical and psychological effects of daylight on students' morale, personality and learning 2.Uniform lighting or regardless of the use of spaces and uniform coloring that causes fatigue, boredom and lack of focus of students 3. Non-compliance with the climate of the region, non-compliance with students' expectations 4. Lack of adequate educational facilities and equipment in schools, which leads to lack of motivation. 5. Lack of sufficient financial resources.
Threats (T)	1. Inadequacy of the body of schools with the expectations of users. 2. Lack of expert opinion and designers and attracting the participation of investors (school-building donors) in the construction and renovation of schools according to standards. 3. Lack of attention to the point of view of educational space users (students) by considering the quantitative and qualitative criteria and standards related to space, in designing and managing learning spaces.	1. Creating stress, lack of interest and declining learning efficiency due to lack of adequate facilities and equipment and the physical space does not fit the expectations of students such as (painting, proper lighting, fresh and generous atmosphere etc. 2. Endanger the cooperation of funders (school-building donors) if educational productivity does not meet the expectations of parents and educators.

Table 7. Hidden Micro-Factors Affected by Natural Light in Learning Productivity; Based on Scree Plot Test (Source: Authors).

Row	the Text of the Statement Measured in the Questionnaire
1	A monotonous, anxious environment and pleasant environments encourage the child to be active.
2	The physical space of the school as a second home; It should play a role that the student feels loved.
3	In addition to the functional aspect, daylight is a factor for teachers' educational activities and efficiency.
4	With the help of environmental factors and paying attention to the student's wishes: Satisfaction is achieved from the educational environment.

5 Socialization of the environment, influenced by nature; It affects the collective activities of students.

VI. Conclusion

In this study, students' learning productivity regarding the use of light has been studied based on five important components: 1. psychological component 2. Inclusive learning component 3. Environmental body component 4. Motor behavior component 5. Environmental comfort component.

According to the results of the study of experts and audiences, it has been found that daylight as an independent variable, affects the physical and mental health of users, in addition to being the most important factor to see. It effects on five factors: 1. Daylight, dynamism of educational activities 2. Non-uniformity of educational environment 3. Physical environment as a second home school 4. Satisfaction and attention to user demands 5. Sociability as a hidden variable, through the connection of indoor and outdoor space and the use of educational spaces of different degrees of natural light affect the spirits and learning productivity of elementary students.

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