

Impact of Educational Building Design on Users' Psychological and Physical Well-Being – Case Study High School in Egypt

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1 ABSTRACT

The design of educational buildings can significantly impact the well-being of their users, both psychologically and physically. Hence, psychological and physical factors are key concepts in evaluating educational buildings' performance as they affect the occupants' well-being, comfort, productivity, and satisfaction. These factors are interrelated and influence each other in complex ways. Therefore, it is essential to design and maintain educational buildings that balance both psychological and physical factors to create optimal learning environments for students and teachers.

This paper aims to execute an analytical study of the relationship between the design of educational buildings and users' physical and psychological well-being. It focuses on the case of schools designed by the General Authority for Educational Buildings in Egypt, which are often characterized by typicality and lack of diversity. It examines the quality of educational institution design, which includes aspects such as Functional, behavioral, and aesthetic. It also highlights the importance of creating educational environments that are conducive to learning, health, and comfort for students and teachers.

Educational building design is a multidisciplinary and complex topic that requires a holistic and user-centered approach to optimize the users' well-being and performance. The methodology adopted for this study includes an analytical study of the relationship between architectural design and users' physical and psychological well-being. Certain methods for data collection will be adopted for this purpose: observations, surveys, and questionnaires.

Through this study, a conceptual framework model is developed that can guide the design and evaluation of educational buildings in Egypt. The model is based on a literature review of significant criteria and considerations that affect the quality and performance of educational environments. The criteria and considerations include aspects such as spatial organization, functional efficiency, environmental comfort, social interaction, and aesthetics. The model is then applied to a sample of high schools in Egypt to test its validity and usefulness. A questionnaire survey is also conducted to collect data on the user experience and satisfaction of students and teachers in these schools. The results of the study are expected to provide insights and recommendations for improving the design and assessment of educational buildings in Egypt.

Keywords: educational building design, users' well-being, design analysis and evaluation, psychology, standards of school design

2 INTRODUCTION

“One of the essential roles of architecture is to provide built environments that sustain the occupants' psychological well-being. This role is made even more important because, in modern society, more than 70% of a person's lifespan is spent indoors.” (Kim, 1998).

Although every building's design is equally vital, the buildings that adolescents deal with are more important than others, because the effect of emptiness on the adolescent's psyche is deeper than if the person is an adult. Therefore, schools are among the most important built environments, the school building has a human and social role that is no less important than its functional role.

In fact, psychological and physical needs during school age are associated with educational success, the development of a healthy lifestyle, and reduced risk of adverse socioeconomic outcomes, psychiatric disorders, self-harm, and suicide in later life (Kidger et al., 2012). Over the last decade, evidence has been accumulating on the relationship between environments and users' health within a “user-centered” perspective (Gifford, 2007). This approach aims at planning and designing spaces that align with the needs, preferences, and behavioral responses of current and potential users, as well as with the instrumental goal for

which those spaces have been created. For this purpose, the interaction between the setting features and functions and the users' characteristics and activities should be taken accurately into account.

In sum, school building design is supposed to play a central role in the creation of environments that improve educational attainment. Promoting a higher level of design humanization in a school environment means taking into account its spatial-physical configuration, in order to increase the outcome in terms of both learning and well-being, especially when considering the high proportion of time that both staff and students spend at school each week.

Consistent with the user-centered design approach, the construct of “design humanization” has been developed, particularly for school environments (Fornara et al., 2006) (Nagasawa, 2000) referring to those spatial-physical features that influence users' responses. Although the educational process is established for the sake of the human being, it often begins without paying attention to basic human considerations. It is logical for the designer to place physiological goals such as health, comfort, and security next to psychological ones such as belonging and privacy along with technological, legal, and economic determinants, as it was found that school spaces affect the student in three directions:

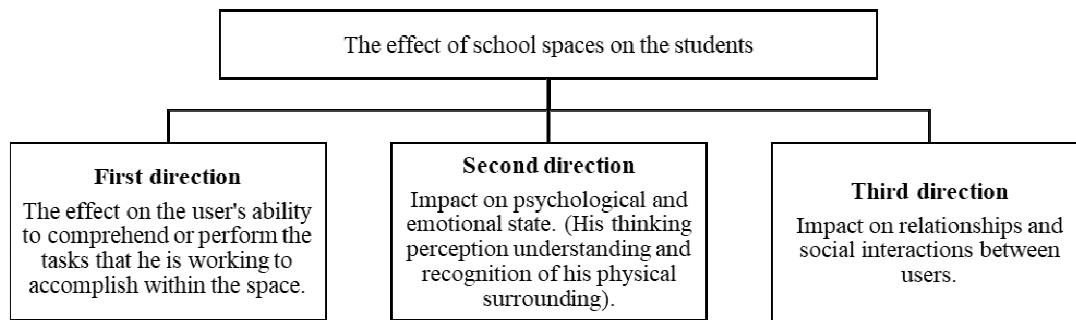


Figure 1: The effect of school spaces on the students (Source: Moharram, 2005).

As a result of these effects, human behavior is determined, which the architect must be aware of in order to avoid negative behavior and its design stimulates the positive behavior of the student towards the surrounding space (Moharram, 2005).

By presenting the psychological and physical requirements of the students during school time, as well as the design principles that are meant to fulfill their needs, and in order to monitor the possibility of applying this on the ground, a field study had to be conducted on a case study of a selected school.

Design principles provided a solution to the challenges produced by traditional school architecture while also allowing for the development of many schools in some global situations. In this paper, An example from an Egyptian high school is presented and analyzed in this paper. How pupils adjust to it and design requirements for schools that care about users' psychological and physical well-being are established. The example shows how the school environment affects the pupils' mood, motivation, and performance. The paper argues that schools should consider human factors in their design and provide a comfortable and stimulating learning space for the pupils.

3 MATERIALS AND METHODS

The methodology of this research is based on a descriptive and qualitative approach. An initial survey to investigate the relationship between the architectural design of educational buildings and the psychological and physical well-being of users was conducted. It focuses on three main factors (function, behavioral, and aesthetic). Function refers to how well the building meets the needs and expectations of users. While behavior refers to how the building affects the users' actions and interactions. Aesthetics refers to how the building appeals to the users' senses and emotions. Certain methods for data collection will be adopted for this purpose, observations, surveys, and questionnaires. The observations allow to capture characteristics of either space itself or its users; surveys allow essentially assist the analysis of the physical characteristics of space; the questionnaires identify and evaluate in a fast and structured way, the needs and satisfaction of users.

The paper uses an analytical study method that examines a case study of a school in Egypt and identifies the key factors that contributed to its performance. The paper also discusses the implications and recommendations of the findings for the design of schools in Egypt.

The analytical method begins with providing descriptions of the samples. It covers the location of the school building, its components, the size of the project, its area, and the number of students in it through its engineering drawings, which were obtained from the Public Authority for Educational Buildings. The performance of the structures' interior spaces is then examined from a functional, behavioral, and aesthetic perspective. In addition to outlining the flaws and their causes, the results also document the benefits and drawbacks of the designs of those schools using the evaluation scale.

3.1 Selected case study

An architectural study of Abdel-Moneim Amer High School is conducted, a public high school located in Kafr El-Sheikh Governorate, Egypt as shown in Table 1. The study examines the school's physical components, such as its buildings, facilities, spaces, and layout, and evaluates their suitability for enhancing students' psychological and physical well-being. The study also identifies the strengths and weaknesses of the school's design, which guides in proposing criteria for improving existing schools or designing new schools in similar contexts. The criteria will be based on three main categories as follows:

- Functional aspects: building form, scale, accessibility, and circulation).
- Behavior aspects: social interaction, common spaces, and social spaces).
- Aesthetic elements: coloring and linking to nature

The main method employed to achieve the study's objective was filling out the evaluation tables with numerical ratings from 1 to 10 for different patterns, which aided in comparing and analyzing the patterns based on various criteria and dimensions. The evaluation analysis sought to document the evaluation of each section as well as the degree of achievement in each, in addition to the benefits and drawbacks of the buildings. Three sections make up the evaluation tables:

- Measuring the functional aspects of a building's performance, such as its shape, design, and circulation, is the focus of the first section.
- The behavioral components of building performance, which deal with psychological variables including privacy, productivity, and social interactions, are measured in the second section.
- The final section measures the aesthetic aspects of a building's performance, including color and Linking to nature (Physical variable).

To do this, we analyzed the building codes of nine countries that have different standards and regulations for this type of construction. We extracted the main elements of the evaluation from each code and assigned them a weight based on their frequency and relevance. This allowed us to compare and rank the elements according to their significance in the design process.

To find out and determine the weight of each element of the evaluation, the building codes for educational buildings were analyzed for nine different countries that have different standards and regulations. The main elements of the evaluation from each code were extracted and were assigned a weight based on their frequency and relevance. This allowed us to compare and rank the elements according to their significance in the design process as shown in Table 2.

For instance, the functional aspect is calculated as: their weight in the evaluation = $X / 108$, where 108 represents the total number of elements of the functional aspects, which is the product of multiplying 12 elements by the number of 9 different countries. Whereas, the behavioral aspect: their weight in the evaluation = $X / 45$, where 45 expresses the total number of elements of the behavioral aspects, which is the product of multiplying 5 elements by 9 different countries. While the elements that can be measurably expressed in the aesthetic aspect are two elements, therefore the aesthetic aspect: their weight in the evaluation = $X / 18$, which is the product of multiplying 2 elements by the number of 9 different countries.

As a result, components are rated from 1 to 10 after being evaluated in accordance with the chosen system evaluation. According to element weight. Each aspect was calculated independently (with a 100% internal computation that made up 33.33% of the overall result).

The functional, behavioral, and aesthetic aspects are fixed. Sub-aspects and indicators can be changed depending on the study's emphasis, the region it is conducted in, and the data that are accessible, which offers future studies more flexibility to add or delete indicators.

3.2 Analysis of the architectural design of the school (data analysis)

Abdel-Moneim Amer High School is located in the city of Al-Riyad - Kafr El-Sheikh Governorate, in Delta Egypt, and is affiliated to the Kafr El-Sheikh Educational Administration, on a Street with a width of 8 m, and it is one direction for vehicular traffic, and the school is located in the middle of a residential area (The General Authority for Educational Buildings, 2011). The school consists of one building consisting of 5 floors, and it contains one open courtyard. The following table shows the descriptive analysis of the school.

Item	Descriptive analysis
School name	Abdel-Moneim Amer High School
Major activity	High school
Designed by	Educational Buildings Authority
Project size	2219 m ²
Main component	(12 ordinary classrooms, 2 laboratories, courtyard, Library, Multipurpose hall, football yard, and administration area)
Number of floors	5-Story school building
Number of students	430

Table 1: Descriptive analysis of Abdel-Moneim Amer High School (Source: Author).

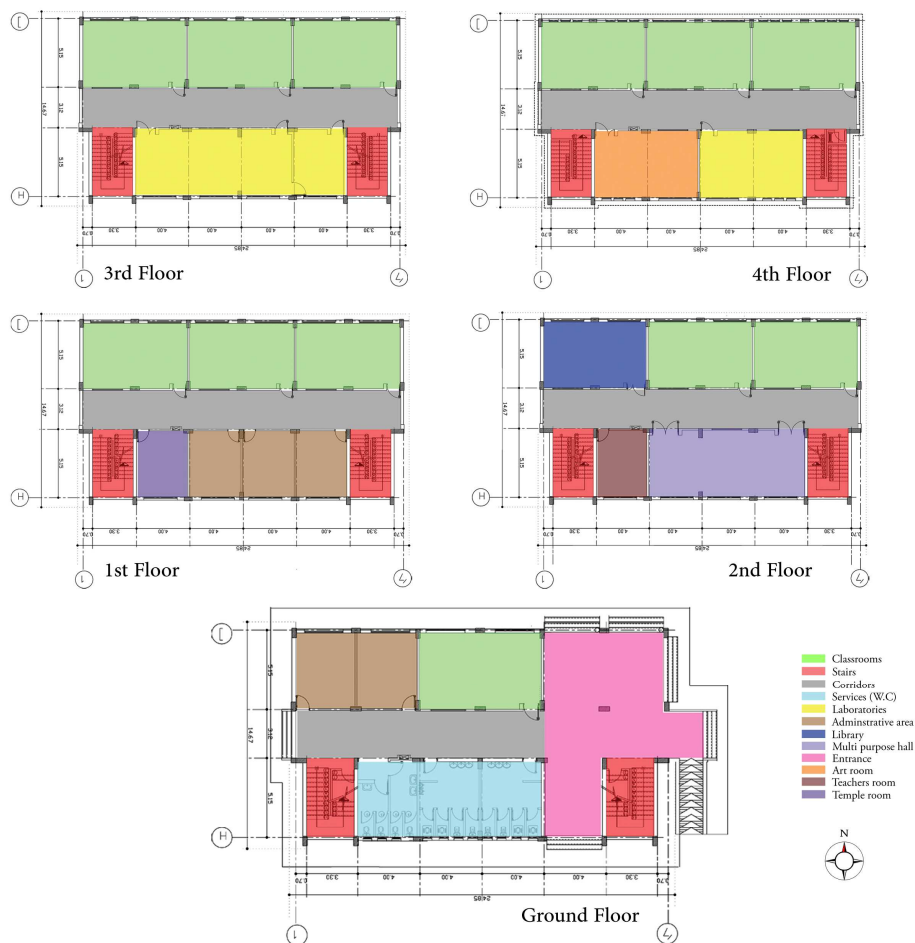


Figure 2: Plans of Abdel-Moneim Amer High School (Source: The General Authority for Educational Buildings, 2011, modified by author).

3.2.1 Evaluation analysis

By observing the characteristics of the building and its components and analyzing it as illustrated in Figure 3, the evaluation analysis is displayed. As depicted in Figure 3, it clarifies the main criteria that influence school users from three different aspects.

Functional Aspects	Code of India	Code of USA	Code of UK	Code of Finland	Code of Japan	Code of Qatar	Code of Lebanon	Code of Saudi Arabia	Code of Egypt	Weight (108)
Spaces design and scale										
Size of classroom	1.2 m ² /St.	2.1 m ² /St.	2 m ² /St.	1.5 m ² /St.	1.5 m ² /St.	1.5-2 m ² /St.	1.5-2 m ² /St.	1.6 m ² /St.	1 m ² /St.	9
No. of students in the classroom	40	30	30	24	30	-	-	25	36	7
Ratio of classroom	1:1.5	2:3/ 3:4	2:3/ 3:4	2:3/ 3:4	2:3/ 3:4	-	-	-	-	5
Exist storage area	1 locker/ St.	1 locker/ St.	3 m ² / class	1 locker/ St.	3 m ² / class	-	-	-	-	5
Accessibility and circulation										
No. of stairs and elevators	Min. 2	Min. 2	Min. 2	Min. 2	Min. 2	-	Min. 2	-	Min. 2	7
No. of school entrances	1	1	1	1	1	1	1	1	1	9
No. of school exits	1	1	1	1	1	-	-	1	More than 1	7
Comfortable corridors with enough spaces	1.5 m	1.2 m	1.2 -1.8 m	1.5 – 2 m	1.5 –2 m	2.5m	1.5m	-	2.4m	8
Building percentage of the land area, and student’s area of the yard	1 m ² /St.	3 m ² /St.	0.3 m ² /St.	0.6 m ² /St.	0.6 m ² /St.	-	-	400 m ²	200 m ²	7
School form										
Site area to be achieved	-	(400-1200) St.	(1400-1700) m ²	-	-	3500 m ²	-	180 St. or more	1250 m ²	5
General orientation of the classrooms	North/ Northeast	-	North/ Northeast	North/ Northeast	North/ Northeast	-	-	-	North/ Northeast	5
Maximum height of the school	-	-	-	-	-	-	-	-	5 floors	1
Behavioral Aspects	Code of India	Code of USA	Code of UK	Code of Finland	Code of Japan	Code of Qatar	Code of Lebanon	Code of Saudi Arabia	Code of Egypt	Weight (45)
Social need										
Desirable average density in classrooms	40 St./ Class	30 St./ Class	30 St./ Class	24 St./ Class	30 St./ Class	-	-	25 St./ Class	36 St./ Class	7
Providing spaces to increase social activities (cafeteria)	-	1.1 m ² /St.	0.9 m ² /St.	-	-	-	-	-	-	2
Personal psychological needs										
Providing spaces to increase communication (laboratory)	65 m ²	130 m ²	2 m ² / St.	2 m ² /St.	2 m ² /St.	-	-	2.1 m ² /St.	38 m ²	7
Providing spaces to increase communication (library)	(50-150) m ²	(900-1000) m ²	9 m ² /St.	1.5 m ² /St.	1.5 m ² /St.	-	-	2.8 m ² /St.	-	6
Providing spaces to increase communication (sports area)	1500 m ²	300 m ²	(250-500) m ²	6400-3220 m ²	6400-3220 m ²	-	-	Min. 300 m ²	-	6
Aesthetic Aspects	Code of India	Code of USA	Code of UK	Code of Finland	Code of Japan	Code of Qatar	Code of Lebanon	Code of Saudi Arabia	Code of Egypt	Weight (18)
Links to nature (Physical Environment)										
View indoor and outdoor spaces (garden – seating area – fountains ...etc.)	1 m ² /St.	Track 400m	0.3 m ² /St.	-	-	-	-	-	-	3
Outdoor classroom	-	Area of class/2	-	-	-	-	-	Area of class/2	-	2

Table 2: Evaluation weight (Source: Author). Note: These listed values were obtained through educational building codes for each country mentioned.

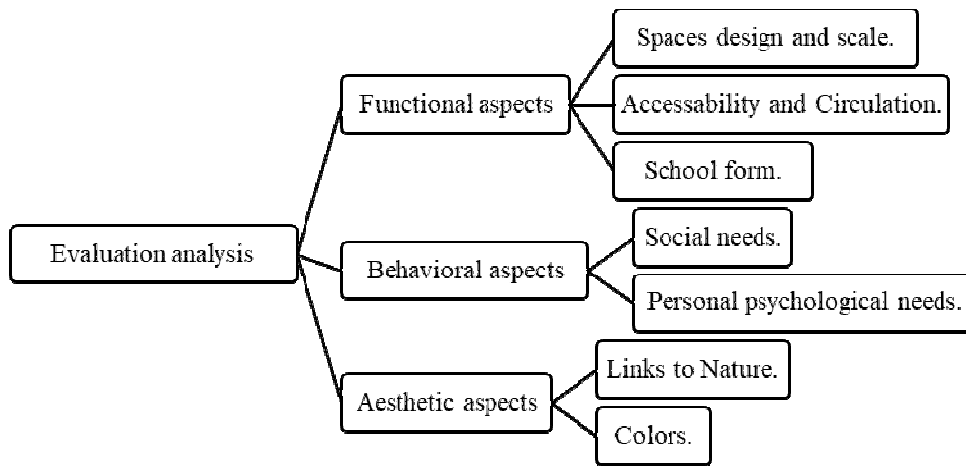


Figure 3: Evaluation analysis criteria (Source: Author).

4 RESULTS OF EVALUATION ANALYSIS

To assess how well the school performed in relation to the case study’s objectives, procedures, and data collection and analysis methods, the tables below are used to track and describe the school's elements and evaluate their outcomes. The functional, behavioral, and aesthetic aspects of Abdel Moneim Amer High School’s performance are evaluated in Tables 3, 4, and 5, respectively, and each evaluation element is shown with its result.

School Name Abdel-Moneim Amer High School							
Evaluation (EV.) %					78%		
		Factor's weight	Total grade	750	585		
Functional Aspects	Spaces design and scale				EV.	EV. by weight	
	Classroom size: The minimum internal dimensions of the classroom = 6 * 8.15 in the case of a rectangular plan, and 7.25 * 7.25 in the case of a square plan, and the net area is 50m ² . The minimum area for each student in the classroom is 1.5-2m ² /Student.		9X	1-----10 Not Achieved - Achieved	5	45	
	The number of students in the classroom or group: 25 students and no more than 30 students.		7X		0	0	
	Classroom scale: 2:3 / 3:4 widths to length.		5X		10	50	
	The storage area in classrooms: Minimum storage area per student (1 Locker/St.)		5X		0	0	
	Accessibility and circulation				EV.	EV. by weight	
	Directly exits from classrooms to the outside, courtyards, or gardens. There must be at least 1 emergency exit.		7X	1-----10 Not Achieved - Achieved	10	70	
	The number of elevators and stairs in the school, with an emergency ladder. (2 stairs/school = 5 floor), (1 elevators/school >5 floors)		9X		10	90	
	The school entrances should be clear and easily accessible; there should be at least 2 entrances to the school.		7X		10	70	
	Clear and comfortable corridors: Minimum width of one-way corridor = 2m. Minimum width of two-way corridor = 3m.		8X		10	80	
	Courtyard or garden. The building percentage of the school is (25-30%) of the land area, and the yard area must be at least 200 m ² , with a minimum of 10m for its smallest sides. The student's area of the yard must be at least (0.6-1) m ² .		7X	10	70		
	School form				EV.	EV. by weight	
	The site area for the high school should not be less than 3,500m ² .		5X	1-----10 Not Achieved - Achieved	10	50	
	The general orientation of the classrooms is to the north, but they can deviate 25 degrees to the east or west from the north.		5X		10	50	
	The maximum height (ground + 4 floors).		1X		10	10	

Table 3: Result of functional aspect evaluation analysis (Source: Author).

The results show that Abdel Moneim Amer high school achieved 78% of the functional criteria, but only 33.9% of the behavioral criteria and none of the aesthetic criteria, as illustrated in Tables 3, 4, and 5 respectively. These low percentages indicate serious deficiencies in the design of the school, especially in the behavioral and aesthetic aspects, which affect the users' efficiency and educational attainment negatively.

Therefore, this paper highlights the importance of addressing these deficiencies and improving the design quality of educational buildings.

School Name Abdel-Moneim Amer High School						
Evaluation (EV.) %					33.9%	
Behavioral Aspects			Factor's weight	Total grade	280	95
	Social need	(Density)			EV.	E.V. by weight
	Desirable average density in classrooms would be about 30 Students / Classroom		7X	1-----10 Not Achieved	0	0
	Social need (Common spaces and active learning & social spaces)					
	Providing spaces to increase social activities among students, such as (Cafeteria, green areas, etc.). Cafeteria: (1 m ² /student)		2X		0	0
	Personal psychological needs				EV.	E.V. by weight
	Providing spaces to increase communication: Laboratory: (1.5-2 m ² /student).		7X	1-----10 Not Achieved	5	35
	Providing spaces to increase communication: Library: (1.5-2) m ² /student.		6X		5	30
	Providing spaces to increase communication: Sports area: 30% of the outdoor school area		6X		5	30

Table 4: Result of behavioural aspect evaluation analysis (Source: Author).

School Name Abdel-Moneim Amer High School						
Evaluation (EV.) %					0%	
Aesthetic Aspects			Factor's weight	Total grade	50	0
	Links to nature (Physical Environment)				EV.	E.V. by weight
	Views of indoor and outdoor spaces (garden, fountains, sitting areas, etc.), (0.5-1) m ² /Student.		3X	1-----10 Non-Existing	0	0
	Outdoor Classroom: the school provides outdoor classrooms that allow students to study overlooking a natural view, (area of classroom/2).		2X		0	0

Table 5: Result of aesthetic aspect evaluation analysis (Source: Author).

Questions (n = 40)	Yes		No		Maybe	
	No.	%	No.	%	No.	%
Q1: Is the number of students in the class more than 25 students?	33	82.1	1	2.5	6	15.4
Q2: Do you feel that the classroom space is insufficient for the number of students?	17	41	13	33.3	10	25.6
Q3: Does the classroom have storage units for each student's personal belongings?	5	12.8	32	79.5	3	7.7
Q4: Does the school design contain at least two stairs?	37	92.3	2	5.2	1	2.5
Q5: Can you walk with your classmate next to each other in the corridors between classes?	38	94.9	1	2.55	1	2.55
Q6: Is there at least one emergency exit in the school?	26	64.1	10	25.6	4	10.3
Q7: Is the number of entrances to the school not less than two entrances?	36	89.7	4	10.3	0	0
Q8: Can schoolyard accommodate all the students during break, or when doing morning activities?	28	69.2	2	5.2	10	25.6
Q9: Do you feel thermal comfort in the classroom if the windows are open?	9	23.1	21	51.3	10	25.6
Q10: Is there a cafeteria (restaurant) where you can sit with your friends during a break?	2	5.1	37	92.3	1	2.6
Q11: Is the school has laboratories, not less than two laboratories (computer lab, science lab)?	36	89.7	1	2.6	3	7.7
Q12: Is there a school library through which you can search and study?	27	69.2	6	12.8	7	17.9
Q13: Are there sports fields (football, basketball, etc.) equipped and usable?	14	35.9	21	51.3	5	12.8
Q14: Does the school contain aesthetic elements (trees, fountains, seating areas, pergolas, etc.)?	16	38.5	12	30.8	12	30.8
Q15: Is there an outside study space (Outdoor classroom)?	11	28.2	25	61.5	4	10.3
Q16: Do you like the colors of the paints at school?	10	25.6	22	53.8	8	20.5

Table 6: Questionnaire results (Source: Author).

After analyzing and reviewing the results of the psychological and physical elements of the users in its three aspects (functional, behavioral, and aesthetic), for Abdel Moneim Amer High School, results of the questionnaire for high school students are presented in Table 6, as the number of students in the school reaches 430 students distributed over 12 classes, which makes the study sample for this level consists of (35-40) students.

From the questions and answers presented in the questionnaire, Figure 4 summarizes the response rate for each question separately. Through the percentages shown, we conclude that the functional aspect of the school achieves the highest rate of user satisfaction, despite the presence of deficiencies in some of the functional elements of the school. Then the percentage of users' satisfaction decreases for the behavioral

aspect of the school, but it is almost non-existent in terms of the aesthetic aspect, as it lacks many elements and thus does not capture the satisfaction of users.

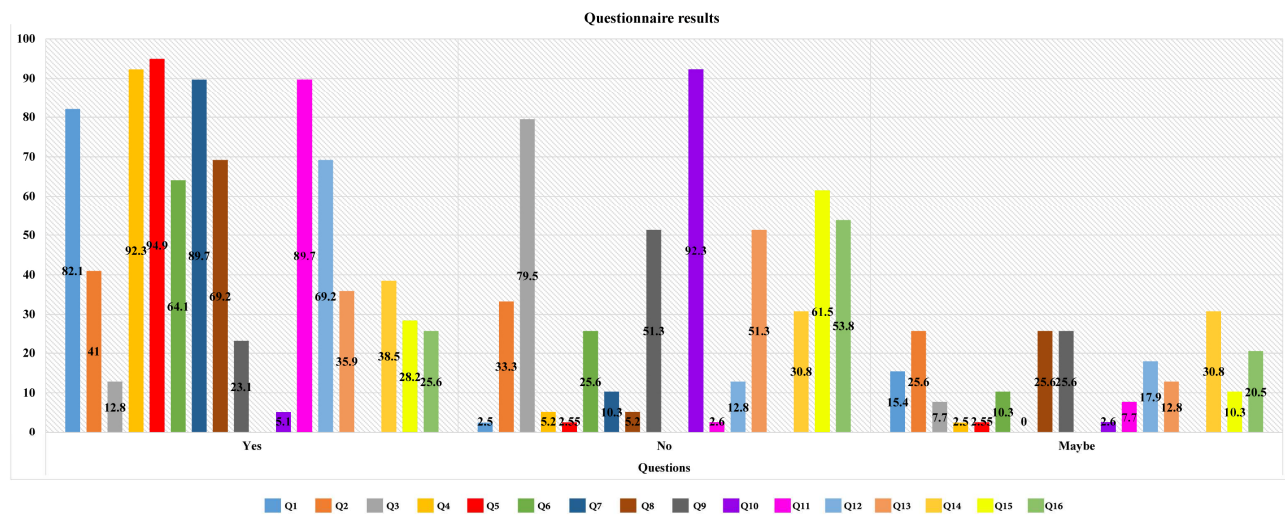


Figure 4: Percentages of questionnaire results (Source: Author).

5 CONCLUSION

This study is considered a step forward in improving school design by keeping in mind the psychological and physical well-being of students, which affects their performance. The discussion follows the application of architectural design principles of psychological and physical well-being to the selected samples, which are divided into three sections. The discussed outcomes were the result of an evaluation sheet developed based on (C. Kenneth Tanner's, 2008) studies, which used an evaluation sheet filled out by designers to evaluate the performance of schools based on architectural psychology studies.

To understand the design tools that should be used to apply the architectural design principles of psychological and physical well-being on users, a case study proves that the design elements aspects of the architectural design of physical and psychological well-being are categorized into three aspects; Function, Behavioral, and Aesthetic aspects. Those aspects clarify the essential elements that help to achieve the best space performance.

Accordingly, the impact of applying these aspects in architectural spaces design by discussing each element's psychological and physical effect on users is a strong impact of architectural space design elements on users. These proofs lead to a link between the design of educational buildings and the psychological and physical well-being of users.

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