The ability of virtual reality to assess the psychological aspects of educational spaces

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Abstract

The purpose of the experimental investigation was to determine whether virtual reality technology might be used to measure psychological factors. To fulfil the study's objective, the researcher built a 3D model of a school that would be shown to physically impaired people in a virtual reality (VR). A checklist was created to ensure the school meets the needs of physically challenged students. The researcher followed two paths to prove the research hypothesis:

1. Immersion of the disabled in a virtual model to obtain their responses to the different educational spaces.

2. Evaluation of some experts in the field of (Architectural Design-Interior Design).

The results of comparing the two courses revealed no statistically significant differences between them, supporting the research premise that virtual reality has the potential to promote psychological considerations in learning environments. The scientific contribution of the thesis is the design criteria that consider the psychological, social, and mobility needs of the disabled, the use of virtual reality technology with a Head Mounted Display (HDM) system in evaluating educational spaces according to psychological aspects, as well as using this technology in the process of architectural design and participation of users in the design processes to know their requirements.

Keywords: *Virtual reality - psychological considerations - Educational spaces - Social considerations - physically disabled.*

1. INTRODUCTION

The difficulties that the disabled and their families have when entering schools and utilizing the school's facilities are different from those that their deaf and blind contemporaries experience. [1].

This is due to the unprepared urban environment and the obstacles that prevent them from reaching their schools and moving

between different educational spaces. The immature-designed spaces in educational buildings constitute an obstacle that prevents the disabled from using them, which psychologically and physically affects their performance inside the school and may deprive them of their right to education [2].

However, it is noted that those who are in charge of educational institutions at different levels failed to play their role towards the disabled in creating an appropriate physical and social environment for their inclusion in all institutions, considering their points of view and involving them in the process of designing educational spaces and choosing what suits them [3].

The technological revolution has produced modern technologies that enable users to participate in the process of designing and evaluating architectural spaces, such as virtual reality technology which gives users the ability to freely walk through within virtual design alternatives to architectural spaces, based on three-dimensional simulators.

Therefore, this research is based on simulating a global model for a school in which the disabled are integrated and allowing the disabled to participate in the evaluation of the different educational spaces within the model using one of the virtual display systems, with the aim of knowing the ability of virtual reality to measure a psychological aspect of educational spaces and reaching design criteria that meet the requirements of the disabled in educational spaces.

2. Related Work

The characteristics of space can convey both emotional and physical meanings, so the emotional dimension of architectural design depends on these characteristics. These characteristics also relate to the size of the space, the dimension of the window, the temperature, the brightness of the color, the shape of the space, and the structural details of the architectural spaces.

Make compare users' immersion responses of the user between environments in virtual spaces and real spaces.[5] users in the experiment were asked to rate the experimental adjectives on a scale of nine categories (pleasure, comfort, beauty, calm, simplicity, spaciousness, closeness, brightness, and clarity) using the semantic differential measurement technique. The overall VR condition scores were very similar to the corresponding real room ratings.

[6] indicated that light, color and texture as space-making elements mostly influence the emotional response of users in architectural spaces. It also verified the possibility of replicating this phenomenon in VR simulations in order to assess the extent to which emotional response in VR simulation environment is affected by the same parameters that affect real environments.

The results of the experiment showed that simulating design features in a virtual space can convey the same awareness of the emotional aspects of spaces in the real world.

In another study [7] conducted an empirical user study whose main objective was to classify users' response to environmental visual stimuli, by analyzing biometric sensory data that could be the primary user sensations of "comfortable/positive" and "non-conforming" architectural spaces comfort / passive. It has been found that when users encounter architectural spaces in virtual reality that are specifically designed to elicit negative emotions, such as vertigo or claustrophobia

and others, we can discern arousal responses related to negative emotions.

According to previous studies the ability of virtual reality to immerse the user in virtual environments and make the user Realizing of the emotional aspect of architectural spaces. this means an opportunity to experience architectural spaces in terms of their characteristics such as color, light, texture, the proportion of spaces and the extent to which spaces affect the psychological state.

3. The needs of the physically disabled students in schools.

3.1. Social needs of the disabled.

The physically disabled suffer from weakness in social relations, and therefore stay away from groups and fail to form friendships with their classmates, until the disabled feels that he is a member of the group, he needs to know its activities and interests, and he also needs more spaces in school to meet their needs as follows:

3.1.1. The Necessity of Success in Social Roles and Strengthening Social Relationships

These needs can be met by considering the following:

Provide a space of (20:25) m2 for one room in to train the disabled on social skills.

Provide a space of 9:16 m` for small group rooms to support the disabled and it is preferred to be distributed next to the staff rooms [8].

The need for Success in social roles: this can be met by using small-size learning spaces with low-ceiling that help the disabled to participate in group learning activities, give them a more positive sense of themselves and feel a sense of responsibility than users of large learning spaces [9].

3.1.2. The need for easy access within the school

This is met by providing ramps when there are different levels and providing special facilities for the disabled [10].

3.1.3. Sense of belonging

The availability of a space that attached to the basic educational space.

3.1.4. Deprivation of well-being

The availability of space dedicated for social and Entertainment activities for wheelchair users.

The availability of Sensory studios [11].

3.2. Psychological needs of the disabled [12]

The psychological needs of the physically disabled can be met as follows:

3.2.1. Need to feel security

The feel of security is represented in containing the space for its users; Therefore, the ceiling can be treated in dark colors to give a feel of low height and thus the psychological containment of the space.

3.2.2. The need to feel its value among his friends and within groups

This can achieve as follows:

The availability of a space that is attached to the classroom 12:20 m2 to allow the exercise of collective work and view their opinions.

Use violet color in spaces where they share their views in order to be feeling with respect and self-esteem.

3.2.3. The need to feel calm

Calm can be also achieved for the physically disabled by the following:

Provide a room for calm to reduce psychological pressure.

Use cool colors instead of warm colors because they are considered to be calming [13].

The openness of the classroom to the external environment helps to calm down.

psychosocial and social aspects

Calm

Calming rooms

Connection with surrounding

Comfortable

Safety

Reachable

Interest

3.2.4. The need to feel joyful. This can achieve as follows

Provide entertainment spaces to share their friend's play.

The availability of Sensory studios.

3.2.5. The need to not feel guilty

It is preferred to provide accessible spaces and bathrooms that he can use.

After studying the psychosocial and social needs of the physically disabled, design criteria were identified that could meet these needs in each educational space. And the following model illustrates this

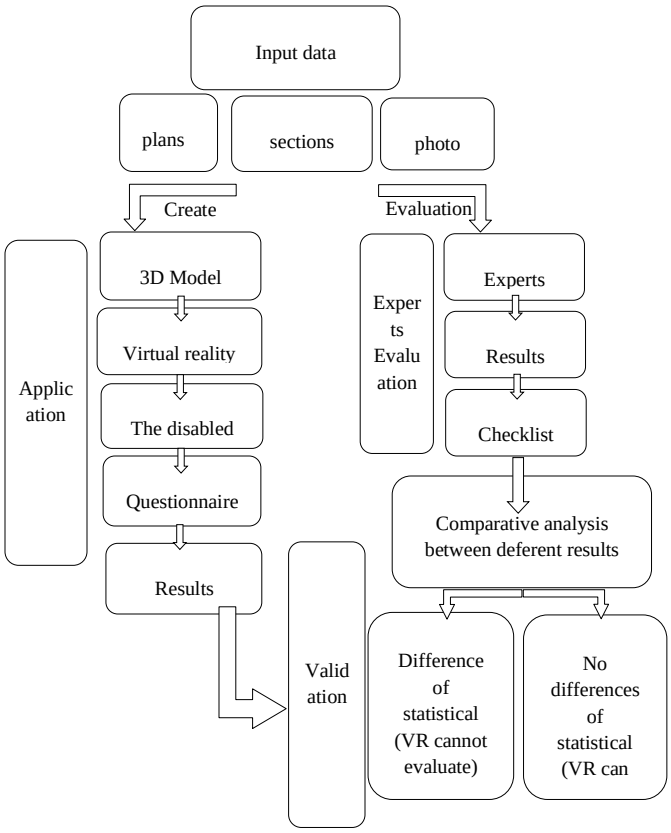
Table 1. shows Explain the psychosocial and social aspects and the Corresponding design criteria of Spaces.

psychosocial and social aspects	Space design criteria
Calm	Using Cold colors
	Calming rooms
	Connection with surrounding
Comfortable	Can use the furniture (height of the work surface – deep under the table)
Safety	Enclosure (height - Length - Width)
Reachable	Access
Interest	Support facilities

Reference: Adopted by the researcher

4. Methodology

4.1. Methodology for conducting the analytical study



This method of validating virtual reality in assessing the psychological aspects depends

on the assessment of the virtual reality by the disabled, and expert evaluation using the checklist, as shown in Figure (1). Following is the presentation of the method:

4.2. Objectives of the analytical study.

The case study aims to realize the ability of virtual reality to assess the psychological aspects of educational spaces.

4.3. The criteria for selecting the case study.

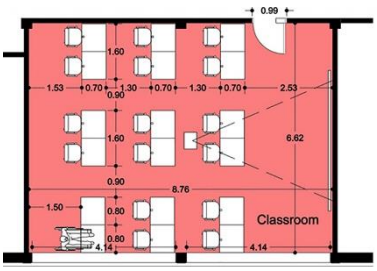
• The case study must include the disabled as an essential element.

• The case study design must include the motor considerations of the disabled (Ramps-access toilet- accessing to the educational space)

• Easy access to pictures and information to facilitate the 3D model and evaluation process by experts.

Blenheim High School's school was chosen because there are study requirements in it, and they will be identified in the table (2).

Table 2. Identification of the selected building (case study).

Blenheim High School		
		
The project Location.	Epsom, United Kingdom.	
Completion Date	1997, Completion of development: 2004.	
Architectural designer.	Architects and Buildings Branch.	
Landscape Architect	Pearson Landscape Design	
Age range of students	15–19 year	

The project area.	Total area = 75500 m²	
building function.	School	

Reference: DfES [Department for Education and Skills,2004]. Transforming schools: an inspirational guide to remodeling secondary schools. Adapted by the researcher.

4.4. Analytical study tools.

• Architectural drawings and photographer to interior space

The virtual school was initially modeled using the 2D CAD application, then exported to SketchUp to create a 3D model of it depending on the plans, sections, and pictures of internal spaces.

The model within the virtual environment is scaled appropriately (the virtual world is constructed at a 1:1 scale). The texture is added to the model as the same materials in reality.

The school's virtual environments consist of 14 spaces (Classrooms- Science lab - Computer lab - Drawing rooms - Music rooms - Library - Multipurpose halls - Sports activities - Schoolyard - Outdoor sporting - Internal corridors - Toilet - Entrance outdoor - Entrance indoor). The furniture will be added to these spaces to be evaluated by the disabled.

Table 3. Example of a classroom from checklist.

Classroom			Yes	M.B	NO
Calm	Colors used	Wall: green in chair, blue and yellow			
		Ceiling: white			
		Floor: gray and green			
	Connection with surrounding	The area of the window openings shall not be less than (20%) for the surface of the separation Window height:2.2 m			
		Window width: 4.10m			
		Window height from the floor:0.25 m			
Comfortable	Height of the work surface	The height of the desk/table can be adjusted			
		The height of the work surface of the desk/table is between 0. 71m and 0.86 m above the floor			
		A clear space is at least 0.68 m from the floor to the underside of the desk/table			
	Deep under the table	A clear space under the table is at least 0.48 m deep			
		The bottom edge of the chalkboard is no			

		greater than 0.61 m above the floor			
	Furniture type	The use of not fixed furniture			
Safety	Enclosure	A height of at least 3 m			
		A width of at least 6.6m			
		A length of at least 7.9m			
Reachable	Deferent level	The floor level is flat and there are no different levels			
	Obstructions				
	Corridor width	The width of the corridors between tables is at least 0.90 m.			
interest	Support facilities	Attach a small group room 12-20 m2			

• Checklist

The checklist for the design criteria is collected. This checklist will be presented to the experts to evaluate the case study (plans indicating the dimensions of the space and the distribution of furniture - section indicating the heights - internal shots to clarify the colors of the walls), as shown in table (3).

• Questionnaire for psychological Adjectives

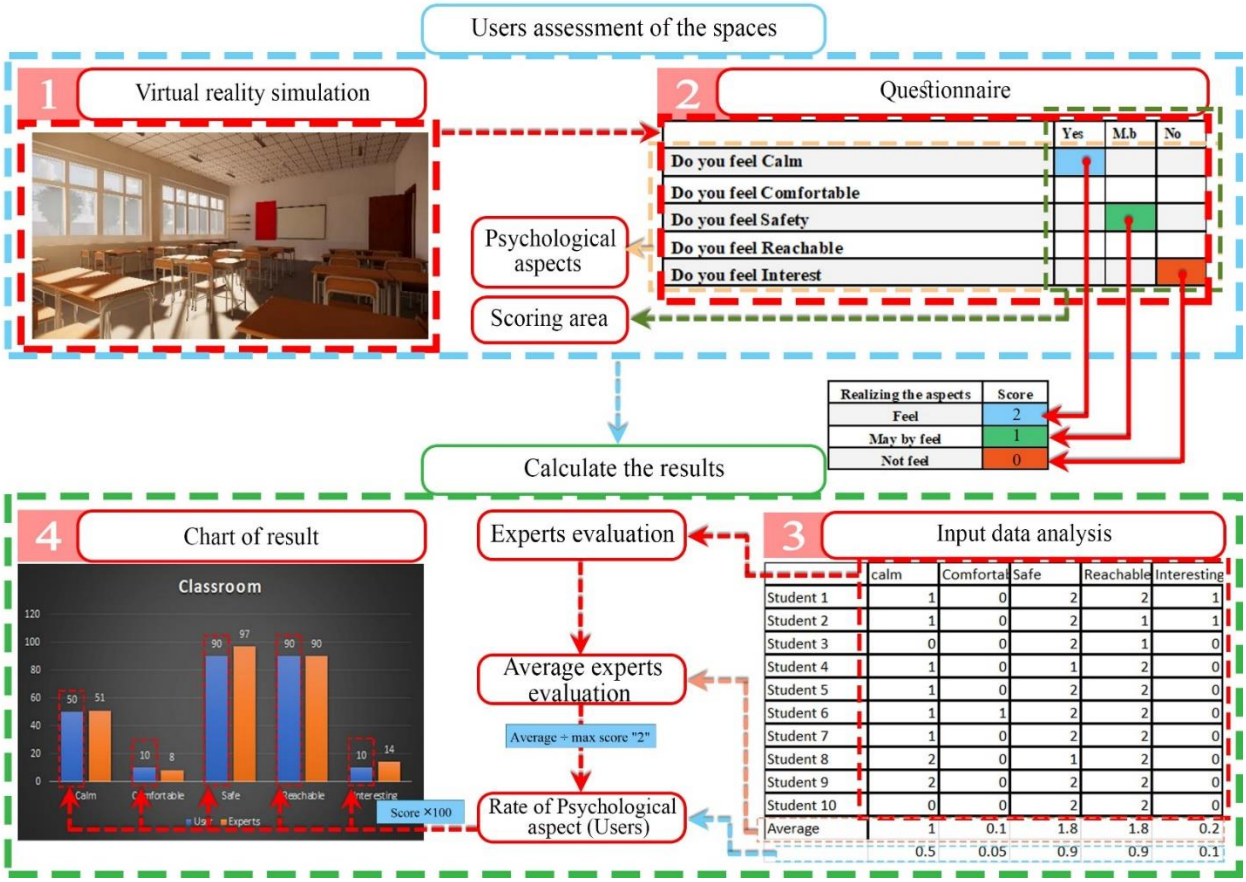
The researcher prepared a questionnaire for the students to assess the psychological aspects of the case study. It consists of a pair of opposite adjectives, as shown in table (4).

Table 4. The psychological Adjectives and its opposite.

Question	Yes	M.B	No
Do you feel Calm			
Do you feel Comfortable			
Do you feel Safety			
Do you feel Reachable			
Do you feel interest			

Reference: Adopted by the researcher.

Figure 2. Method for calculating ratings scores for user



Reference: Adopted by the researcher

5. Method

5.1. Application

Creating a 3D model of the study case by using the (plans, sections, outer shots, internal shots).

Displaying the 3D model for users by using a display system for the virtual reality "Head Mounted Displays (HDM)".

Asking users through a pre-prepared opposite-adjectives questionnaire to assess the psychological aspects of the spaces.

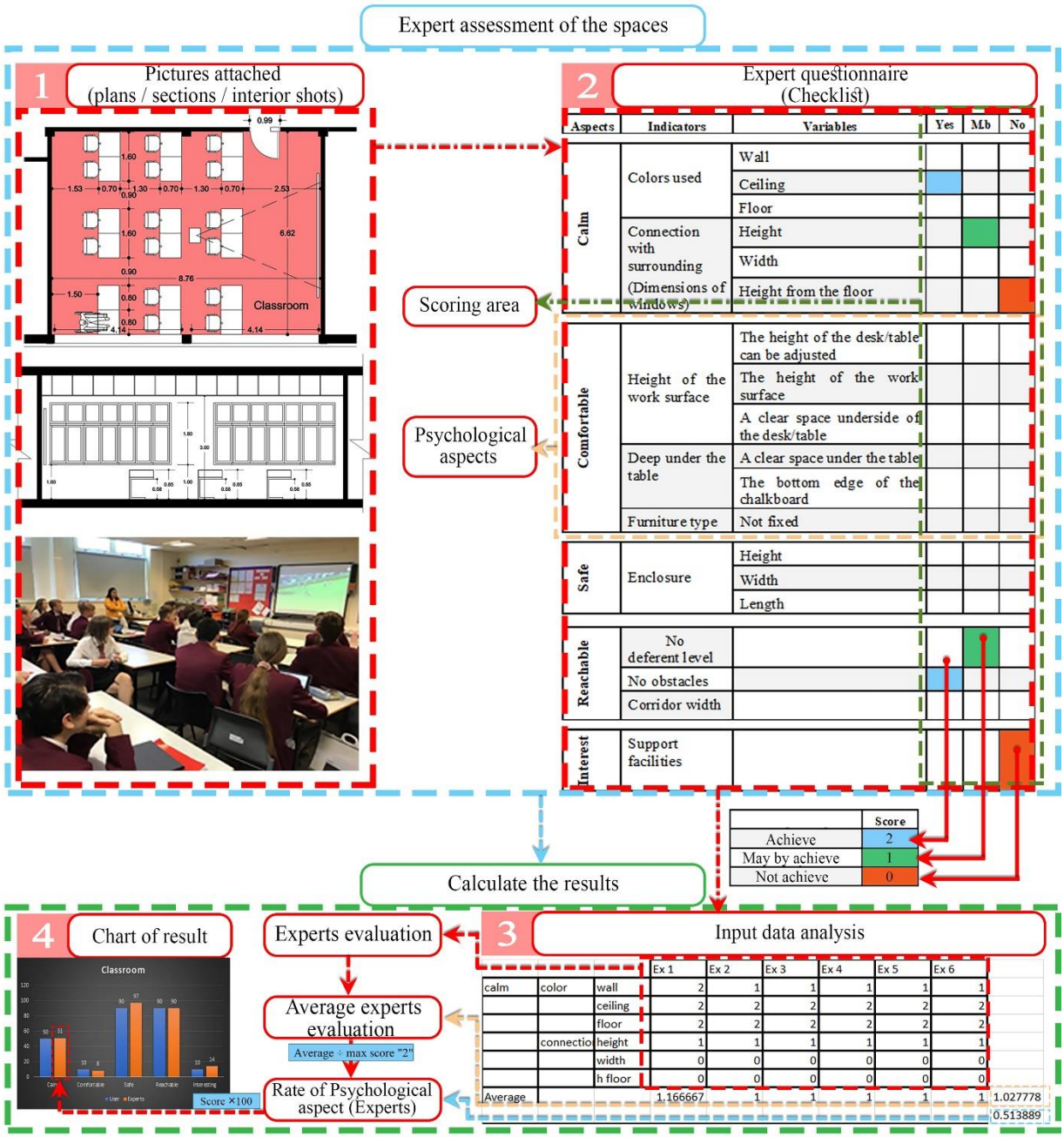
Extracting the results from the users' assessments to be compared to the expert's evaluation results, as shown in Figure (2).

5.2. Expert's evaluation

The researcher analyzed the psychological, social and mobility needs of the disabled, and also the case study. The checklist was extracted and collected in table (3).

The experts evaluated the case study by using the checklist and the attached pictures, to be compared with the results of user evaluation, as shown in Figure (3).

Figure 3. Method for calculating ratings scores for exports



Reference: Adopted by the researcher

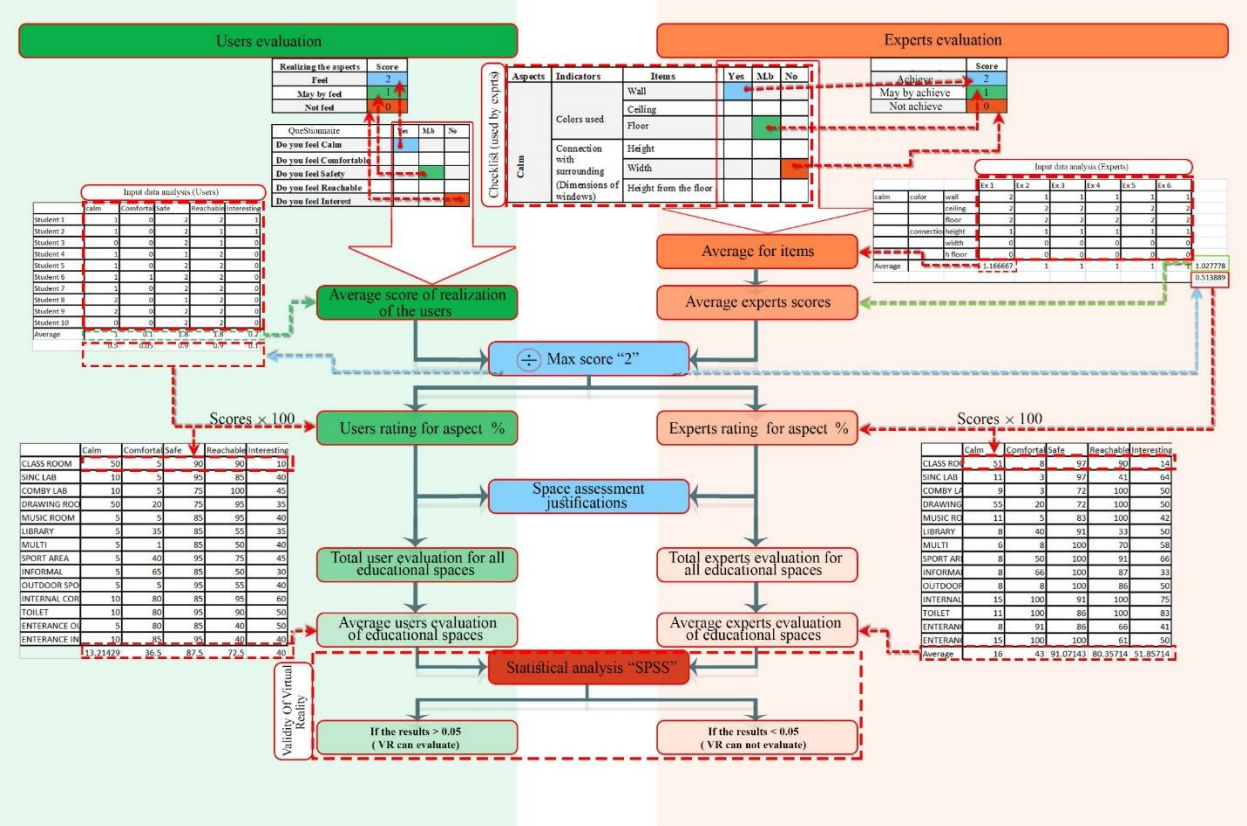
5.3. Validation

In order to determine the validation of virtual reality by using Head Mounted Displays (HDM) to measure the psychological aspects, the research will compare the results of the questionnaire with the results of the expert evaluation and it will be analyzed by the statistical analysis program SPSS, as shown in Figure (4).

The data will be statistically processed by using (SPSS, 24.0) program and compared by Mann-Whitney tests due to the small sample size. If the results show that P>0.05, this indicates that there are not a statistically significant differences between the responses of the two samples, which proves the ability of the HMD to measure the psychological aspects.

But, if the results show that P <0.05, this indicates that there are statistically significant differences between the responses of the two samples, which proves the disability of the HMD to measure the psychological aspects.

Figure 4. Method to reach the validity of virtual reality



Reference: Adopted by the researcher

6. Experiment proceeding

Ten physically-disabled students were selected from different schools. Participation in the experiment was voluntary.

Some experiments were held in the students' houses, and the others were held in the researcher's house, in order to facilitate the special conditions of the disabled.

The table (5) shows the choice of the user properties and where to perform the experiment.

Table 5. Identification of the user properties.

The study sample	
Number of the disabled students in the city	12 students, there are 2 cases of cerebral palsy
Number of the accepted	10 students

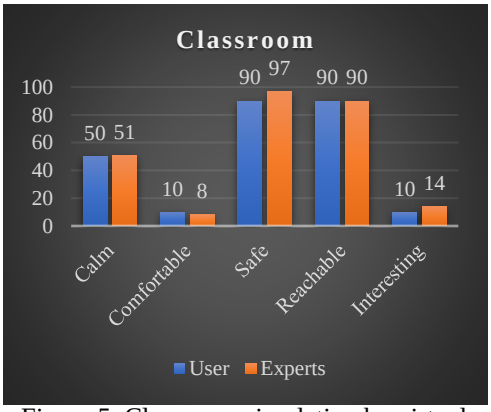
students	
Male	4 students
Female	6 students
Age	15: 18 years
Disabled limbs	9 students with lower-limb disability and one student with lower- and upper- limb disability
Study site	North Sinai, El Arish
Place of the experiment	Students' houses and the researcher's house

Reference: Adopted by the researcher.

6.1. Assessment of school spaces

The assessment will be presented through a statistical diagram showing the results of the psychological aspects (Calm- Comfortable- Safe- Reachable- Interesting). Then, it will be explained to clarify the concluded result in terms of design criteria.

Table 6. Results and Analysis of the evaluation of experts and disabled for the classroom.

Aspect	User rate	Expert rate	Analysis	
Calm	50%	51%	The white color does not give a feeling of calm.	
			The connection to the external environment is insufficient.	
Comfortable	10%	8%	The use of furniture for the disabled does not give a feeling of discomfort.	 Figure 5. Classroom simulation by virtual reality.
Safe	90%	97%	The dimensions of the rectangular spaces and the low height gives a feeling of safety.	
Reachable	90%	90%	Ease of access to spaces gives a feeling of being reachable.	
Interesting	10%	14%	The lack of spaces to present opinions leads to a feeling of lack of interest.	

Reference: Adopted by the researcher.

6.2. Results Analysis

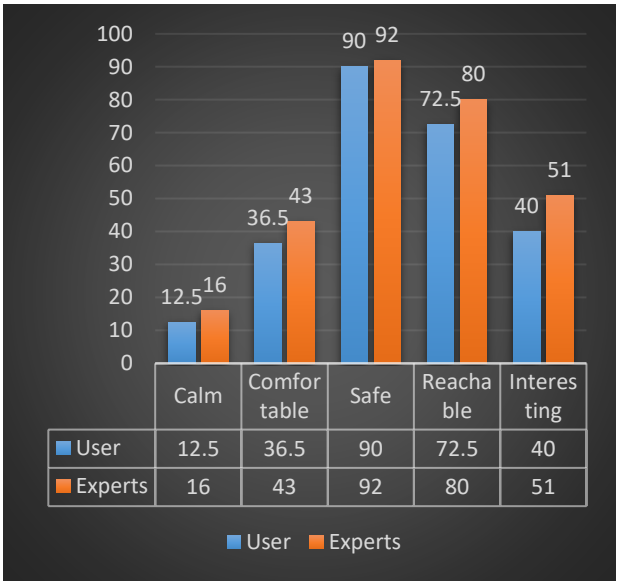
The results of statistical analysis and chart will be presented and analyzed to reach the conclusions of the case study. They will be explained as follows:

The results showed that there were no statistically significant differences between the mean rank of students' responses to the four aspects (Calm, Comfortable, Safe, Reachable) and the mean rank of the corresponding design criteria in the experts' evaluation for different school spaces; Calm ($p = 0.069$, $p > 0.05$), Comfortable ($p = 0.473$, $p > 0.05$), Safe ($p = 0.275$, $p > 0.05$), Reachable ($p = 0.25$, $p > 0.05$); but there were statistically significant differences for the aspect of Interesting ($p = 0.016$, $p > 0.05$).

The following statistical chart explains the statistical differences between the disabled's

response and the expert's evaluation in the different school spaces.

Figure 6. Comparative users' perception and professor evaluation.



Reference: Adopted by the researcher.

7. Conclusion

The psychosocial requirements of the disabled are discussed in this study. In order to meet the design criteria, the characteristics of the spatial areas are therefore investigated, and each criteria is assessed using virtual reality.

• The research provides a studied methodology about how to use the proposed tool (Head-mounted displays (HMD)) for evaluating the psychosocial and social aspects of the disabled. It has proved effective in realizing the psychological aspects of the spaces. Thus, the architectural spaces can be evaluated through it at an early stage before the establishment of projects. Accordingly, the research hypotheses have been proven as follows:

1. The analytical part of the research concluded the validity of virtual reality investigating psychological state of the disabled in educational space.

2. It is important to take into consideration the psychological, social and mobility state of the disabled within the school spaces to overcome their disability and live their life normally without other's help. It also makes them feel equal to their classmates and have the ability to participate in all school activities, which is reflected in their academic achievement and self-proving.

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