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Virtual reality Adaptability in Architecture Heritage Education Egyptian Universities Survey

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Abstract

Since architecture is created in a field of tension between reason, emotion and intuition, architectural education should be regarded as the manifestation of the ability to conceptualize, coordinate, and execute the idea of building rooted in human traditions.

The problem of the **gap between architecture students and their heritage**, to fully understand the architecture of historical buildings, their design, features, decorations, construction, utilization of material, integration between nature and light to enhance users experiences and their own innovative thinking, students must see those places themselves, to feel the proportions and the design story behind every corner and detail, the research problem is that the traditional education of architecture heritage cannot fully accomplish its objective.

The aim of the research is to compare two learning methodologies: the traditional education of architecture history, and the interactive virtual reality integration in education. The main objective of the study is to survey the current educational system of architecture heritage then, evaluate the new methodology that assumes that the use of friendly technology in the classroom makes it much easier and satisfying for students to follow the subjects, allowing better acquisition of the skills they are learning.

Keywords:

History of Architecture, Virtual Reality, Field-Education Connection, Architecture Education Analysis, Field survey

Introduction:

Architectural history is the discipline that records, studies and interprets architecture. It studies its forms, purposes, and most importantly its evolution. Fortunately, ancient architecture can easily be observed and recorded. Studying architectural history enables us to understand the society and culture they represent, which is very useful when working as a contemporary architect.(architecture courses, 2022)

The study of architectural history allows students to understand the cultural, social, and political context in which buildings and structures were designed and built. This can help inform their own design decisions and give them a deeper appreciation for the buildings they encounter. Architectural history can also help students understand the origin of the design process and how different design decisions can affect the final product.

Virtual reality can improve education by providing students with memorable and immersive experiences that would otherwise not be possible. What's more, it can all take place within the classroom. VR is accessible to every student and can be easily monitored by teachers. Virtual experiences have the power to engage and inspire students in a unique and powerful way.

A literature about the current education of architecture in Egypt was reviewed, (Dessouky, 2016), (Attia et al., 2018), (W. A. ABDEL KADER, 2018), (E. A. Aboushal & Mohamed Salah Gharib, 2021)and (Biblotheca Alexandria, 2023), all the review concluded that a great deal of consideration should be given to planning for the educational process dedicated to architects, bearing in mind that the architectural education is an ongoing process that lasts a lifetime. Architects are students all their lives, they should be able to learn new things and start in new directions at any age.

Another review focused on the integration of virtual reality in architecture eduction and its benefits, the review of (Amber Bartosh & Phillip Anzalone, 2019), (Agnieszka Gębczyńska-Janowicz, 2020), (Hala Sirror, 2021), (Ibrahim et al., 2021), (Şahbaz, 2020)and (Ibañez-Etxeberria et al., 2020), (Aydin & Aktaş, 2020)argues that the integration of virtual reality as important and most of the objectives aimed form architecture education could be achieved through it.

This research aims to introduce employment of virtual reality in Egyptian architecture educational system as an approach to enhance history of architecture education using digital technology and close the gap between architecture students and their heritage.

Methodology

This research addresses the gap between architecture students and their heritage, the first part of the research is a survey about current methodology of architecture history education in Egypt, then a review about the aim of architecture education and difference between 2D visualization and 3D visualization, then an introduction about extended reality as a new method of visualization, and successful employment of virtual reality in international architecture history education methodologies, finally a questionnaire on the existing curriculum of architecture history education in Egyptian universities and recommendations for its improvements are suggested.

1. Egyptian Architecture Education

For many years, the sector of architecture education has been growing. The field of education always made a positive impact. In response to the requirements of the inhabitants, architects changed the forms and patterns of the city. Program for architecture do not currently provide the necessary integration between academic study and the demands of profession.

In many colleges around Egypt, architectural education is primarily offered as an engineering course. With the exception of Cairo University's faculty of regional and urban planning and Azhar University's faculty of engineering's urban planning department.(Attia et al., n.d.)

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The current system of architectural education in Egypt follows National Academic Reference Standards (NARS) for architectural engineers and the following academic reference standards presented in Fig (1) represent the general expectation about the qualifications attributes and capabilities that the graduates of Architectural Engineering programs should be able to demonstrate:

The professional education of an architect is conducted at the university level and can be found in one of three general variants: an undergraduate professional degree (five years required); professional master's degree (two – three years required depending on the type of undergraduate held by the

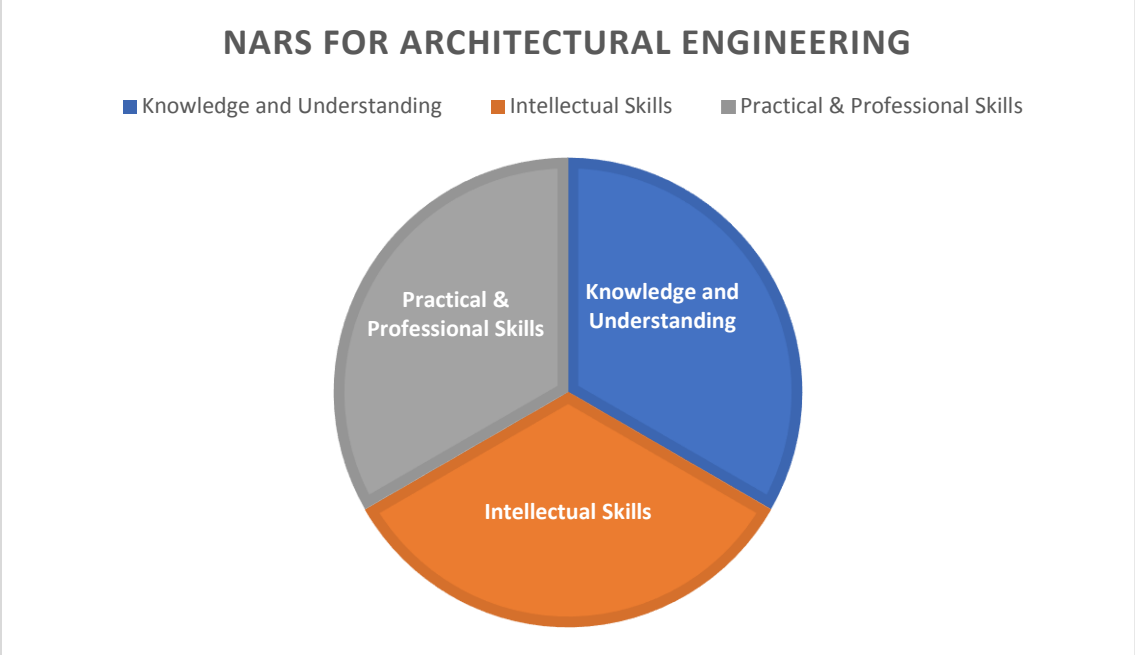

Figure 1: shows National Academic Reference Standards (NARS) for architectural engineers, Source: Researcher

student); and professional doctoral degree (eight years required).

The Egyptian education of architecture has a common set of courses that are learnt at the architecture departments and accomplish the required standards in NARS, those courses are basic sciences, design and drawing studio, construction and technology, humanities and social sciences and representation, visualization, and form.

The courses degrees follow the credit hours system as the students must complete a certain number of hours to be able to level up from each semester, in Cairo University the curriculum of the AET program consists of 180 credits, in Suez Canal University it consists of 177 hours.

1.1 Architecture education aims

Since architecture is created in a field of tension between reason, emotion and intuition, architectural education should be regarded as the manifestation of the ability to conceptualize, coordinate, and execute the idea of building rooted in human traditions.

The attitude of viewing architecture as an art can be found in Middle East architecture schools, where students are encouraged to study picture books. What makes the situation worse is the influence of western trends that have conquered Middle East architectural education and even the profession crisis has been influenced by western architecture.

Several studies confirm that there is a lack of knowledge among architects. There are very few buildings in Egypt that can be classified as architecture. With rare exceptions, architects deny the functional and aesthetic of people. Their buildings lack concept and language and very few have social relevance. An evaluation study to assess and examine the design and planning of some housing projects. The study reported that there are several design errors pertaining to the concepts of privacy, character circulation and way finding. The different types of activities and the open spaces seem not to have been examined at all. Another factor is that the architectural design studio-the backbone of the education of architects rarely includes any research activity. Based on the view that the content of design should be directed toward practical ends.

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1.2 Education and objectives

Since architecture is created in a field of tension between reason, emotion and intuition, architectural education should be regarded as the manifestation of the ability to conceptualize, coordinate, and execute the idea of building rooted in human traditions.

Architectural education involves the acquisition of an ability to create architectural designs that satisfy both aesthetic and technical requirements, an adequate knowledge of the history and theories of architecture and the related arts, technologies and human science, an understanding of the relationship between people and buildings, and between buildings and their environment and of the need to relate buildings and the spaces between them to human needs and scale.

Issues related to architecture and the environment should be introduced as part of general education at schools, because an early awareness of architecture is important to both future architects and the users of buildings.

1.3 Difference between 2D visualization and 3D visualization

2D and 3D refer to the actual dimensions in a computer workspace. 2D is "flat", using the horizontal and vertical (X and Y) dimensions, the image has only two dimensions and if turned to the side becomes a line. 3D adds the depth (Z) dimension as shown in fig (2). This third dimension allows for rotation and visualization from multiple perspectives. It is essentially the difference between a photo and a sculpture.(xo3d, 2022)

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3Dgroundworks utilizes cutting edge technologies to capture projected construction, renovation, or restoration. 2D is still effective to convey plans and can be delivered ahead of 3D. The processing power and tools are now

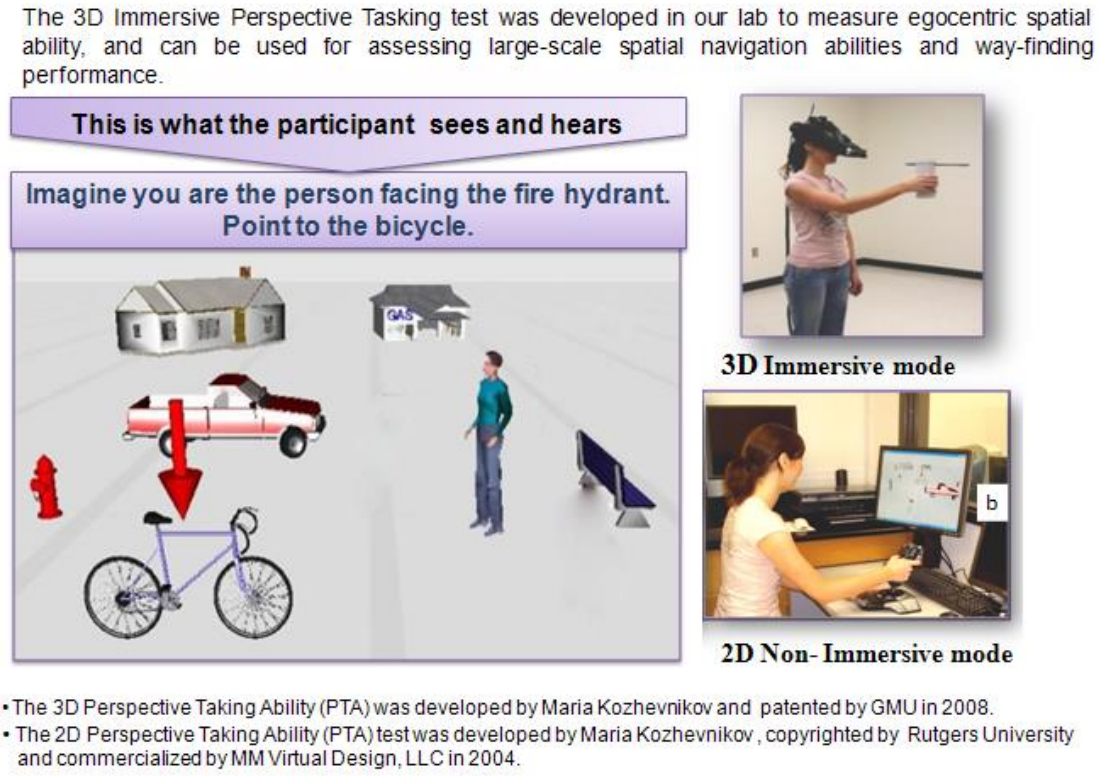

Figure 2: showing Perspective Taking Test Source: http://www.nmr.mgh.harvard.edu/mkozhevnlab/?tag=2d-vs-3d, accessed: 4\6\209, 5:11 AM

able to design and render wonderful results within budget. Confidence in precision data means accurate measurements that can be used from the structure up to simulated interior design options.

2. Introduction of extended reality and education

Visualization. The most obvious benefit of using VR in education (for any other sphere it is also true) is the advanced way of visualization. Virtual reality has become the universal tool to display objects, processes, locations, and historical events.(Jumani et al., 2022)

1) Improvement of education quality
2) Active participation. These days, millennials may perceive conventional classroom studying as a bit boring. Integrating VR into a curriculum is one way to enhance the learning process for them. Besides generating interest, VR can also remove distractions on a smartphone.
3) No language barriers
4) Improving appraising system

2.1Virtual Reality in design studios

Virtual Reality is used in architecture education in the designing process, where it provides a designer with a full image of spatial relationships of design components instead of depending on raw imagining. In other words, VR has this particularity that helps to create the spatial and topological relationships of a design.

The field of education can greatly benefit from the technology known as virtual reality. There is no denying the benefits of allowing students to freely move about virtually recreated historical settings and scenarios in real time when studying a topic like history, and more specifically history of architecture. The student may comprehend the structure of a building and the components that make it in this way, due to virtual reality, in a more natural and intuitive way, using all of their senses as if they were actually there. However, even though the students clearly have an active and autonomous role throughout their visit - they can enter the building of their own initiative, make their own decisions regarding itinerary.(Kamińska et al., 2019)

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2.2Extended reality as a new method of visualization

Extended Reality (XR) as shown in fig (3) is a newly added term to the dictionary of technical words. For now, only a few people are aware of XR. Extended Reality refers to all real-and-virtual combined environments and human-machine interactions generated by computer technology and wearables. Extended Reality includes all its descriptive forms like Augmented Reality (AR), Virtual Reality (VR), and Mixed Reality (MR). In other words, XR can be defined as an umbrella, which brings all three Reality (AR, VR, MR) together under one term, leading to less public confusion. Extended

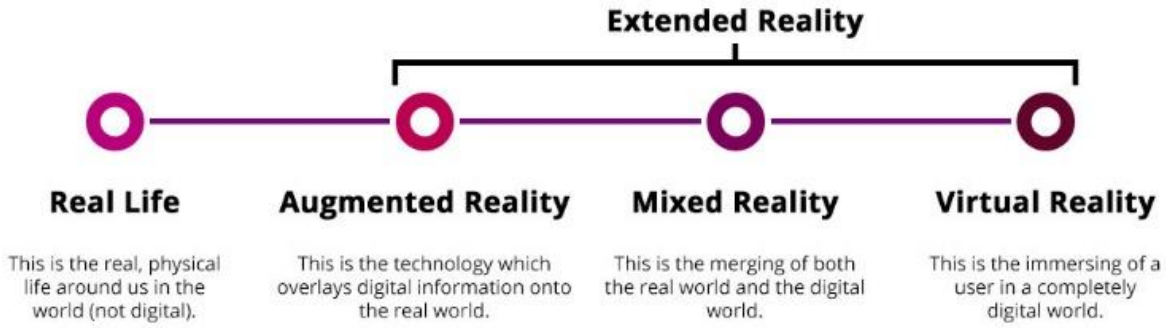

Figure 3: XR explained by Dan Simpson, Source: ROBOT, Extended reality market growing, FEBRUARY 22, 2019, Control Software Oy, https://controlsoftware.eu/index.php/2019/02/22/extended-reality-market-growing/, Accessed 19\5\2019, 5:07 AM

reality provides a wide variety and vast number of levels in the virtually of partially sensor inputs to Immersive Virtually.(Medium, 2022)

Extended reality (XR) is a term referring to all real-and-virtual combined environments and human-machine interactions generated by computer technology and wearables. There are different types of XR technologies i.e., Virtual Reality (VR), Mixed Reality (MR) and Augmented Reality (AR).

3. International examples of virtual reality integration in education

3.1. Virtual Reality Use in Architectural Design Studios in Bahrain

The hypothesis of this research (Wael A. Abdelhameed, 2013)was that the function potential would assist students to have more understanding of the structural system selected, which would be simultaneously beneficial on the architectural design level. A questionnaire was designed and distributed to the students to record their remarks and opinions of using the VR function.

The function goal is to visualize the construction process of a structural system in a certain order. This new function enables the visualization of any possible change in the construction order by changing XML code in an easy way. The virtual reality environment used in this study and research is the Virtual Reality Studio program developed by Forum8, the Japanese company.

A simple methodology is applied by highlighting the changes that students make in their designs and structural systems because of VR use. Around half of the respondents record the effect of VR use as above average and strong while almost half of the respondents view the effect of VR use as average and below average effect. With the VR use, students created more details and modifications inside their designs.

This study has confirmed that VR use is beneficial in the designing phase of the structural system. The VR use increases the awareness of designer during designing in terms of the structural properties and component assembly of the structural system.

3.2. Visualization methods in architecture education using 3D virtual models in Barcelona, Spain

This research (David Fonseca a et al., 2013) compared two learning methodologies: the traditional generation of printed plans, and the generation of interactive 3D models using new systems of publication and interaction as

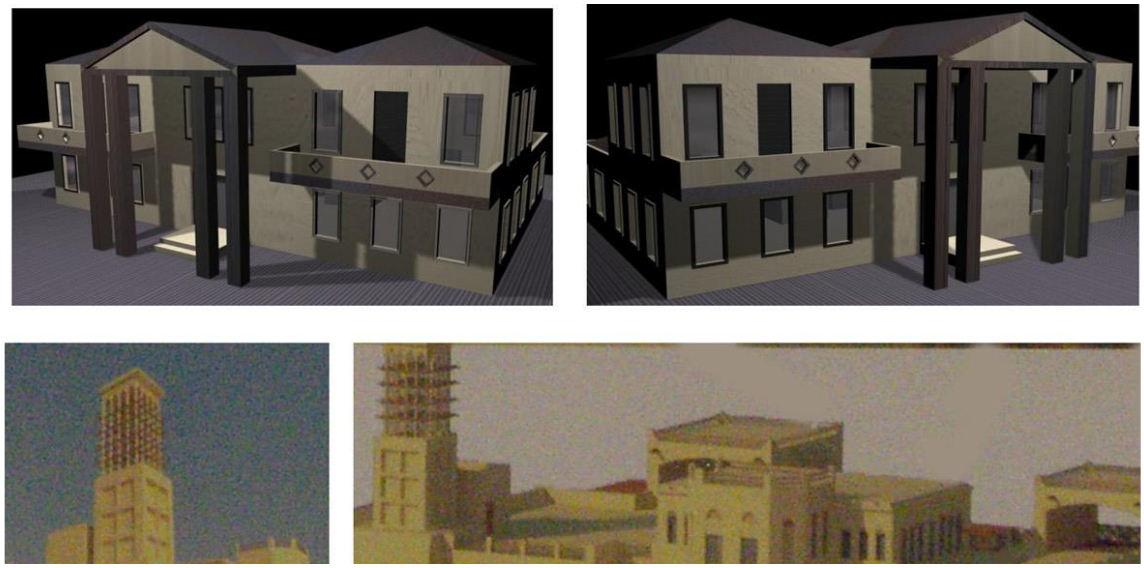

Figure 4: two design examples with final design details by using AutoCAD and 3ds max, Source: Wael A. Abdelhameed, Virtual Reality Use in Architectural Design Studios: A case of studying structure and construction, Procedia Computer Science 25 (2013) 220 – 230

shown in fig (4). The main objective of the study is to evaluate the new methodology that assumes that the use of friendly technology in the classroom makes it much easier and satisfying for students to follow the subjects, allowing better acquisition of the skills they are learning.

The results concluded that using virtual reality helps students to acquire a better spatial understanding of their work, directly contributing to an improvement in their curriculum evaluation.

3.3 Improving the understanding of architectural 3D models: Comparing user spatial perception between immersive and traditional virtual reality systems in USA

This study(Paes et al., 2017) sought to quantitatively verify the ability of a particular immersive system in providing users with a better spatial understanding of the virtual mock-up.

This research aims to investigate and measure the capacity of a particular low-cost, projection-based immersive environment in providing better understanding of a three-dimensional virtual representation compared to the spatial perception obtained using a traditional virtual reality system (non-immersive model).

The main purpose of the perception survey is to collect users' perception on certain space's elements. The sample size was of 30 participants, comprising construction industry professionals (architects and civil engineers), engineers from other fields but also involved with design activities (such as mechanical engineers), architecture students and other professionals.

The results of the study concluded that when using the immersive environment users have a better spatial perception of the virtual space as opposed to their spatial perception using a conventional workstation. The immersive environment allowed users to perceive spatial features more accurately than through conventional virtual reality.

Other findings include the significant relationship between age and understanding of the 3D model. This relationship was found in both conditions, where participants with 26 years of age or older had better perception.

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4. Questionnaire of architecture history education in Egyptian universities

Design of questionnaire

The purpose of this survey is to collect knowledge about the current educational system of the History of Architecture in Egypt, so that a new way of teaching can be suggested to improve the linkage between Egyptian Architects and their historical country.

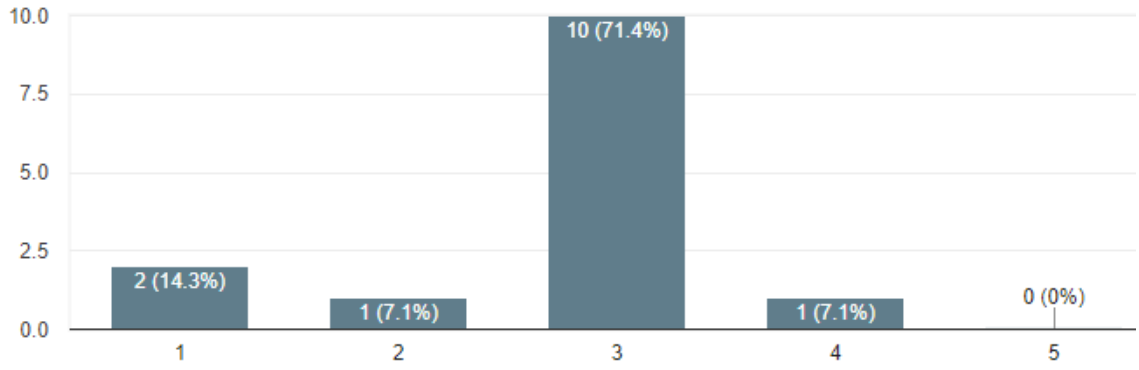
The questions are designed according to the questionnaire aims and delivered to various universities of Egypt which are Alexandria, Suez Canal, Cairo, Ain Shams, Shoruk ,Nilem Port said and Zagazik.

The results of the questionnaire are summarized as follows:

Aim 1: To prove there is a need for improvement for the current history of architecture educational system.

Table 1 Aim 1: To prove there is a need for improvement for the current history of architecture educational system, Source: Author

Need for improvement for the current history of architecture educational system.	Most of the students in Egyptian universities felt intermediate satisfaction with the current system of historical education in Egypt with 71.4% of them rating it 3 in a scale of 1 to 5.

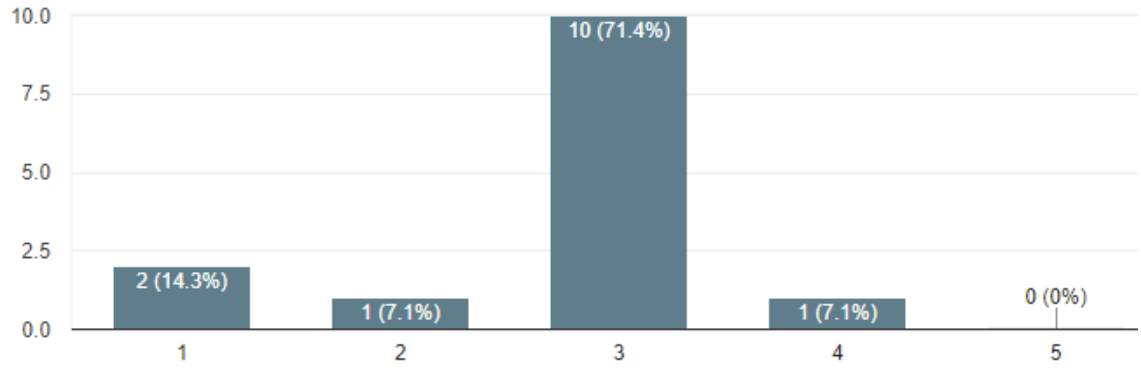


Field trips conducted during Architecture History study.	As for the field trips during the study, it seems that it wasn't essential in the course teaching methodology or the students couldn't afford

	it, as the results show 58.3% with positive response to the question and 41.7% medium.
Participation in field trips	More than half of the students attending architecture history course attended fieldtrips regardless of the constraints and trouble that faced them, and the other half either didn't participate or barely participated.
Constrains of attending field trips	Most of the response was positive to this question and its summary was that it wasn't organized by the actual faculty or the subject TA. The students would go by their own choice, so it was unorganized and some areas in Egypt may not be that protected or dangerous, also it would've been better if the faculty provided a good transportation.

Aim 2: To prove there is a gap between architecture students and their history.

Table 2: Aim 2: To prove there is a gap between architecture students and their history, source: Author.

Need for improvement for the current history of architecture educational system.	Most of the students in Egyptian universities felt intermediate satisfaction with the current system of historical education in Egypt with 71.4% of them rating it 3 in a scale of 1 to 5.
	
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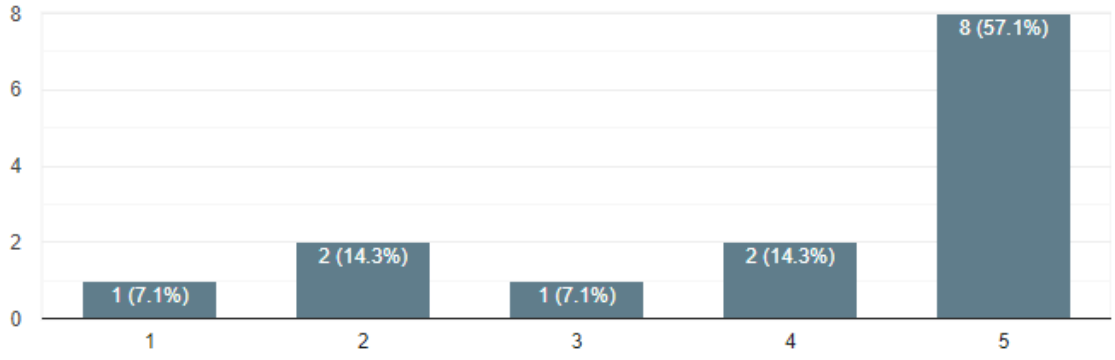
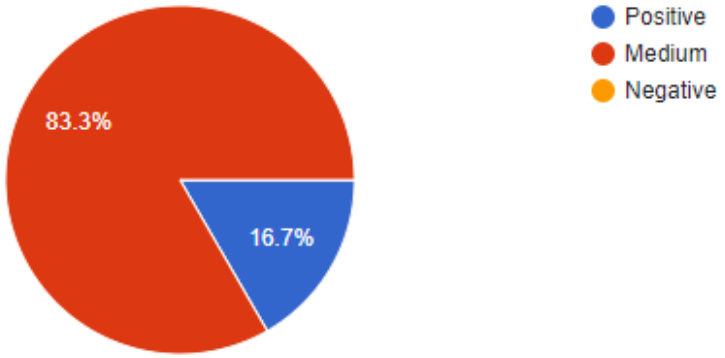
Aim 3: To prove that physically interacting with buildings can help architects understand the design better.

Table 3: Aim 3: To prove that physically interacting with buildings can help architects understand the design better, source: Author.

Remembering what you physically interact with more than what you hear or read	Most of the results were positive with 57% affirmative answer.

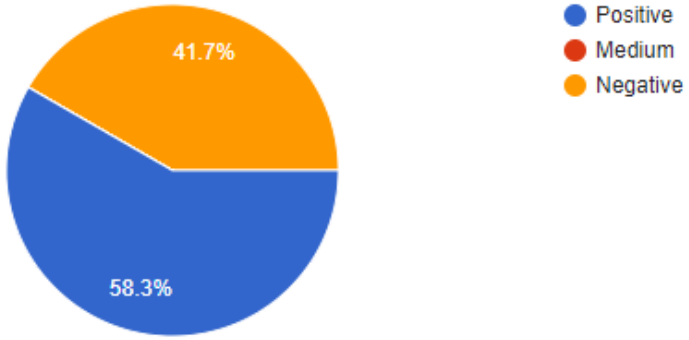


Finding difficulties in understanding the design of a historical building while reading its description	Most of the students felt connected to their history by mentioning it which proves the potential of wanting to learn more and restore it, by after reviewing the resources used in studying history, the critical problem of enhancing teaching methods and resources become crystal clear.



Aim 4: To search the uses of virtual technology in Egyptian education and the other teaching methods.

Table 4: Aim 4: To search the uses of virtual technology in Egyptian education and the other teaching methods, source: Author.

Knowledge about virtual reality and its use in Historical Preservation before	Virtual reality is a new concept that most of the older students doesn't know, let alone integrating it with education, and according to this survey 58.3% of the students already know about this technology which creates opportunities in integrating it with teaching methodologies depending on this this basic knowledge.
	
use any technological or digital resources that could make you understand history better	Most of the students usually search for more resources to understand the history subject better like looking for 3D scenes like that on Google Earth and 360 degree picture and See more and more videos about it, or watching a virtual reality video which them imagine how it was at time of building, and in Alexandria university, its library has got different types of digital technology which they use it in their

	museums. Like the one that show how ancient Egyptians did the mummification process.
Description of attended university History of Architecture	
Suez Canal University	The different architectural styles existed in Egypt through the years and examples of it
Cairo university	Needs more actions and find a way to make us watch all of what they say not only imagine it by luck. Sometimes times the course get very boring.
Port said university	Each course of history was taught in such a way, there's no specific methodology used in teaching history in my university.
El Shorouk Academy	It was displayed in a very simple and effective way, lectures were brief and mostly containing pictures, the most effective part was about making us to make a presentation about any part of the curriculum and all colleges used to compete to reach the most fun and interesting way in presenting the lecture.
Alexandria University	It is all about research and pictures something we make Marquette and videos
Ain shams university	Know about each type of architecture and how it develops to reach the last theme. Study the famous architecture building and its style and elements. By lectures, video's, pictures
Alexandria University Fine Art architecture department	Lecture method, demonstration, and little bit of discussion method.

Conclusion

One of the challenging tasks is to bridge the gaps between student architects and the context of the project. Architecture is, as we said, a 3-dimensional art. However, in the past, due to the lack of a proper technology, we had to invent ways to represent it in 2 dimensions, creating drawings that assisted in the construction of the building or element. No matter how useful and crucial these forms of representation have been, they have, like everything, their own limitations. One of the main limitations is that it makes the learning process slower and much more difficult.

This research addresses the need to improve current educational system of history of architecture, through two parts, the first was an analysis to prove successful utilization of virtual reality in architecture education, the second was a survey and questionnaire to evaluate the applicability of virtual reality integration in historical architectural education.

This paper concludes that there is a need for enhancement of traditional teaching methods of architecture education especially courses that are based on field trips and imagination, through the utilization of aiding software like virtual reality and extended reality that would successfully achieve the aims and objectives of architecture education to graduate professional inspired architects.

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