

Immersive Learning: A Comparative Study of Architectural Student Perception Between Virtual Reality and Traditional Learning Environments

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ABSTRACT

The integration of Virtual Reality with architectural education has increased the need to evaluate its effectiveness and its impact locally. This research aims to measure the effectiveness of virtual reality in local architectural education on students' presence and learning experience, identifying limitations within the scope of the case study, and emphasizing areas that need improvement. The Research question (To what extent can Virtual Reality enhance architecture students' presence and learning experience, along with data on the current situation in Iraq?), also the hypothesis was proposed: learning through virtual reality enhances student presence more than traditional methods. It depends on a comparative mixed-methods approach, including a theoretical stage to develop evaluation indicators, and experimental stage by comparative method in which architecture students were divided to group (A) were taught through traditional methods, while (B) were taught through Virtual Reality. The findings showed that learning through VR enhanced presence compared with traditional methods. The presence revealed a higher meaning for the (B) group (4.33) than for the (A) group (3.33), indicating a disparity between the two learning approaches. In addition, the two groups expressed a preference for VR integration, with an average score of 4.81. The research also identified integration challenges, including technological readiness and managing user-related issues. Finally, this study recommended that curricula in architectural education incorporate virtual experiences supported by laboratories provided with the infrastructure and technologies for VR-based learning, adopting a mixed learning model that blends traditional teaching with VR methods.

Keywords: Architectural education, Immersive learning, Perception, Spatial presence, Virtual reality.

1. INTRODUCTION

Three-dimensional spatial imagination is one of the fundamental challenges for architecture students, as recognizing architectural proportions, scale, and spatial relationships requires an advanced level of sensory engagement and direct interaction with the space. Existing

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architectural education methods, which are based on two-dimensional drawings, images, and videos, generally remain limited in providing students with a holistic understanding of architectural spaces, particularly when physical site visits are difficult because of distance, safety concerns, or the difficulty of observing detailed spatial features through direct experience **(Rzqoo, 2020)**.

With the rapid growth of digital technologies, new potential has emerged to simulate real-world environments through immersive technologies, such as Virtual Reality (VR), which provides an engaging digital environment that allows users to experience spatial presence and immersion. Although VR has been gradually adopted in architectural education in developed countries, its implementation in developing educational contexts, especially in Iraq, is still limited due to the lack of educational spaces designed to support such technologies, insufficient technological infrastructure, and restricted awareness and technical skills among academic staff. These limitations become more critical with Generation Alpha students, whose learning requirements are associated with experiential learning and technology-based educational environments **(Lafta, 2019)**.

Previous studies have indicated the importance of merging digital technologies with educational environments, especially in architectural education. Local studies show that Iraqi architectural education remains dependent on traditional teaching approaches, despite the need for digital transformation. **(Rzqoo, 2020)** revealed significant deficiencies in architectural curricula, highlighting the limited integration of digital technologies with teaching methods and their lack of alignment with labor market requirements. Similarly, **(Hamza, 2020)** studied the relationship between architectural representation and visual thinking in enhancing students' cognitive and spatial abilities. Expanding this perspective, **(Rami, 2022)** proposed a knowledge framework of indicators and mechanisms for modifying Iraqi educational buildings to improve modern educational technologies, including virtual reality, while **(Jumaah, 2023)** emphasized the necessity of developing Iraqi architectural education toward more international approaches. Overall, these local studies show an increasing awareness of digital transformation within education, focusing on curriculum development and educational environments rather than evaluating the educational effectiveness of virtual reality.

The characteristics of contemporary learners have been studied extensively. **(Ziatdinov and Cilliers, 2021)** analyzed the challenges faced by Generation Alpha in higher education and suggested reorganizing educational approaches to accommodate the features and expectations of this digitally oriented generation. Similarly, **(Höfrová et al., 2024)** revealed gaps in digital skills among students and teachers while highlighting the demand for advanced pedagogical approaches. Complementing these findings, **(Coolsaet, 2024)** confirmed that Generation Alpha's learning is highly connected with technological interaction and experiential learning methods. Together, this international research shows that educational environments should incorporate interactive technologies that support the learning preferences of a new generation. International research has further demonstrated the educational capabilities of virtual reality in various fields. Early studies **(Mathur and Shrivastava, 2020)** investigated the limitations of traditional verbal-based teaching approaches and highlighted the ability of VR and AR to increase educational interaction. **(Aydin and Aktaş, 2020)** studied the integration of VR-based learning environments with architectural design education and showed the positive effect of digital methodologies on architectural learning experiences. Furthermore, **(Lara-Alvarez et al., 2023b)** confirmed that virtual learning environments could increase students' academic achievement



compared to traditional classroom approaches. Likewise, **(Erita et al., 2024)** found that VR-based learning improves engagement and critical thinking skills, enhancing its role as a future educational technology. Recently, **(Díaz González et al., 2025)** studied immersive virtual reality in architectural design education and indicated its positive influence on spatial understanding, communication, and academic achievement. Despite Variations in educational methods, these studies consistently validate the positive contribution of virtual reality to learning. Within the local context, studies related to VR and architectural education are limited. Existing studies have primarily addressed the implementation of immersive technologies in heritage documentation and interior design. For example, **(Abdul-Jabbar and Alwehab, 2023)** reviewed augmented reality in heritage environments. Additionally, **(Hashim et al., 2023)** studied the role of VR technologies in enhancing contemporary interior design processes. Although these studies verify the increasing interest in immersive technologies, they do not empirically test VR as a tool in architectural education. Although previous research has confirmed the educational capability of virtual reality, there are limited indications concerning its effectiveness in architectural learning, and observable data regarding the impact of VR on students' presence and learning experience in Iraqi architectural schools remain limited. This gap emphasizes the need to evaluate VR in a local educational setting. Consequently, this study evaluates the effectiveness of VR-based education compared with traditional PowerPoint-based education and recognizes the practical aspects of its implementation in architectural education. In particular, it investigates whether virtual reality enhances students' presence and learning experience. Based on the research gap, this study addresses the following research question: To what extent can VR-based learning instruction enhance architecture students' spatial presence and learning experience compared with PowerPoint-based Learning instruction, along with data on the current situation in Iraq? To answer this question, the research applied a comparative case study through a lesson on the architectural elements of the Hagia Sophia Mosque. The building was chosen because its complex architectural characteristics make it suitable for measuring students' spatial perception while preserving the same content across both learning environments. Two educational approaches were compared: PowerPoint presentations and VR headset experiences, allowing the education method to be the primary variable.

According to the research objective, the following hypothesis was proposed: learning through virtual reality enhances student presence more than traditional methods, thus indicating greater instructional effectiveness. Consequently, the novelty of this study lies in the experimental evaluation of the effectiveness of VR-based teaching in Iraqi architectural education by a comparative study between VR learning and traditional PowerPoint-based teaching to present empirical evidence concerning VR effectiveness in Iraqi architectural education.

2. METHODOLOGY

This study used a comparative experimental methodology to measure students' mental presence in traditional versus virtual reality learning environments. This study was conducted in two stages. The first stage included a relevant literature review to create the theoretical framework, recognize the characteristics of virtual reality learning environments, and establish the indicators used in the experiment for evaluation. The second stage comprised a quasi-experimental comparative study that tested these indicators



by conducting an experimental comparison with architecture students, structured as follows:

- Including architecture students to examine the effect of virtual reality on architecture students' presence compared with traditional learning. The experiment comprised two educational conditions that differed in the delivery method while maintaining the same material to ensure a fair comparison between the groups. Fifty students from all five educational stages participated in the experiment and were selected by purposive sampling, with 10 students from each stage based on recommendations from their supervising instructors to promote variation in learning performance and abilities. Subsequently, the students were permitted to choose the instructional method, which led to two groups of 25 students each. Group A received traditional PowerPoint-based learning, whereas Group B used Meta Q.
- To limit the effect of students' academic level on the experimental results, sample members were selected from all five stages to achieve representation of different levels of ability. Students from each stage were equally divided between the two groups based on their preferred method. Thus, the differences observed reflect the instructional method rather than variations in students' academic levels. Used 2 VR headsets.
- Hagia Sophia Mosque was selected as the lesson because of its complex spatial characteristics, international acknowledgment, and the availability of high-quality 360° virtual reality video content. More importantly, the building itself was not the variable under investigation; it merely served as the instructional content for the experimental session. Therefore, the use of a different building with comparable architectural complexity would not be expected to affect the validity of the findings, as the study evaluates the effectiveness of the learning method rather than the characteristics of a specific building.
- Data were collected by observing students' behavior during the experience and through post-experience surveys.
- Statistical analysis of the collected information was performed using SPSS.

3. THEORETICAL FRAMEWORK

3.1 Contemporary Architectural Education

According to contemporary educational theories, most of whose principles apply to architectural education, it is characterized by several features **(Hamza, 2020)**:

- It changes the behavior of architecture students through knowledge transfer by simulating reality and social conditions, enabling them to see and analyze problems, identify solutions, and develop critical thinking skills.
- Architectural education often takes place within a design studio, which is considered a psychological environment in which students learn. The AIAS Studio report indicates the necessity for the studio to foster a spirit of cooperation and interaction, focusing on the quality of the output and defining the problem rather than a competitive mindset.
- Architectural education is characterized by experiential learning through practical application and solving real problems, thus reducing the gap between education and professional practice in the job market **(Rowe, 2002)**.
- Architectural education is characterized by flexibility, a vital and emerging topic discussed in the context of curricula and globalization.



We found that social constructivist learning theory and experiential learning theory are suitable for the teaching model used to meet the needs of the modern era in architectural education.

The educational process rests on four pillars **(Fadhil, 2015)**.

- The students were classified according to their level of activity (passive or active participant).
- The teacher: The leader of the educational process who plans, manages, and evaluates the results. The teacher follows one of two systems in the teaching process **(Hamza, 2020)**: (traditional system and interactive system)
- Curricula: Lleris developed an educational model in which he showed that learning consists of three Summits: perception, emotion, and society (environment). In accordance with the requirements of contemporary education, the fixed curriculum has been replaced with a dynamic, interactive, problem-solving, and multidisciplinary curriculum. This change can be used as an indicator of the need for modernized educational facilities.
- Educational Environment: This is characterized by providing the functional requirements for education and the social and cultural activities that combine education and work. The educational environment has three pillars: educational, physical, and social **(Aljumaili, 2012)**. It is defined by the relationships, time, and activities that occur within it **(Fadhil 2015)**.

3.2 Technological Transformations in Education

Educational technology is defined as a complex and comprehensive process that includes people, ideas, methods, techniques, and tools for analyzing problems, selecting solutions, implementing them, improving them, and managing them. In this process, education is considered a directed and controllable goal **(Alayouia, 2014)**. The role of technology in developing the educational field is evident in several points, as follows **(Muppudathi, 2014)**:

- Providing feedback to students and teachers and evaluating the effectiveness.
- Enabling access to the largest possible number of students
- Providing greater opportunities for self-learning
- Providing the necessary resources for the educational process
- Developing teaching strategies and methods according to individual and social needs

Digital education emerged to facilitate the learning process, particularly given the difficulties societies face in accessing educational environments due to natural disasters, pandemics like COVID-19, geographical distance, wars, and other challenges, and boasts several key advantages **(Revathi and Shwettha, 2019)**:

- Flexibility and ease of use for the community
- Secure record-keeping
- Continuous access to global developments
- Easy understanding of unfamiliar concepts thanks to advancements in teaching aids.
- Reduced cost and effort

The era of communication has witnessed a shift in the focus of education from the transfer of knowledge to interaction, discussion, critical analysis, and encouraging participation **(Malhotra, 2015)**. This shift has given rise to the term "digital learners," referring to individuals who possess the ability to access, integrate, and utilize digital information



efficiently, effectively, and easily to achieve specific goals. Prensky categorized generations based on their ability to use digital information into two groups (**Prensky, 2001**):

- Digital natives who were raised in a world where digital technology was already embedded in everyday life.
- Digital immigrants belong to a generation shaped by traditional print-based environments, experiencing digital technology as a foreign concept they must consciously learn to adapt to much. They commonly occupy the role of educators for the generation that grew up digitally. According to Prensky's classification, they are the first generation of native digital citizens. The current generation is Generation Alpha, those born between 2010 and the present (**Höfrová et al., 2024**). One of the most important characteristics of a digital learner is self-reliance in learning, possessing several qualities including independence, open-mindedness, inclusiveness, innovation, curiosity, authenticity, and trust (**O'Regan, 2000**). Analyzing these characteristics, we observe that this generation needs a new model for teaching and learning (the digital learning model), centered on the student as a self-directed learner who focuses on understanding and building knowledge through exploration, participation, and interaction, with the teacher's role being that of a facilitator in the process (**Ramlee and Kashefian-Naeeni, 2017**).

3.3 Immersive Learning

Learning typically occurs experientially in the physical environment. However, when experiencing a particular situation is difficult, the experience can be conducted within virtual environments that simulate the original physical environment. When a virtual environment closely mirrors the real world, it influences the level of immersion it produces, creating the perception of being physically present within that space. This type of experience is known as immersive learning (**Mystakidis and Lympouridis, 2023**). Immersion represents a phenomenological experience and a state in which human awareness of self and time fades due to the desire to interact with the stimulus. This term is derived from the concept of immersion in water, meaning a reality that surrounds and controls the human senses.

In the context of virtual reality, it is used to denote the advantages of the technology and is equivalent to the concept of spatial presence, which indicates a mental presence in a place different from the person's actual location. Immersive learning is supported by an array of physical and digital technologies (**Mystakidis and Lympouridis, 2023**):

- The physical side includes simulations, role-playing, and games, in which learners must actively engage with the material, and education goes beyond simply delivering content to include exploration and critical thinking.
- The digital side of immersive learning is comprised of three technologies: Virtual reality, augmented reality, and mixed reality.

3.4 Virtual Reality (VR)

Craig and Sherman defined it as a new interactive communication method that emerged as a result of technological development (**Sherman and Craig, 2002**). defined it as a simulation of a specific reality through experience in a three-dimensional interactive visual environment with synchronized movement, sound, and other forms of communication such as touch. Webster's New Universe defined it as being present in the effect or essence but not in reality. (**Al-Zubaidi, 2024**) defined it as a three-dimensional world with time that does not exist in real life. It is accessed through specialized tools and includes several levels,



starting with written descriptions and ending with the representation of complete three-dimensional environments with numerous realistic effects. Its goal is to stimulate human senses and perception. It is characterized by the ability to move within the virtual environment and view different angles, accompanied by visual and auditory effects that increase immersion. Virtual reality systems include several pieces of equipment, such as the interactive head-to-head (HMD), which achieves a high level of immersion (**Sherman and Craig, 2002**). There are also virtual caves, which are small enclosures where the virtual environment is projected onto the walls using screens or projectors that work together seamlessly (**Cardona Reyes et al., 2023a**):

- Interactivity: It provides the ability to respond to and interact with environments through auditory, visual, and sensory capabilities.
- Immersion: This engages, creating an experience that transports the individual from the physical world to a virtual world, thus impacting their consciousness and perception. It affords a multi-sensory immersive experience incorporating visual and tactile elements.
- Flexibility and the ability to refine and expand.

3.5 The Essential Components of Virtual Reality Systems in Education

Virtual reality allows for the visualization and comprehension of complex scientific information through virtual learning environments that simulate reality, such as observing what happens inside an atom or visiting planets and space. This provides a more interactive learning experience, enabling the practice of new skills and allowing for repetition and error correction (**Mathur and Shrivastava, 2020**). It also provides access to learning for people with disabilities, in addition to promoting collaborative learning and creating relationships between students despite their geographical distance. Furthermore, it fosters self-directed learning (**Alzubaidy and Al-Tameemi, 2024**). A wide range of hardware and software is available for creating virtual environments, and their use is determined by financial constraints and specific needs. We will discuss common systems in the educational field (**Abdul-Wahid, 2022**):

- Window on World System (WOW): This system uses a computer screen to display the virtual environment.
- Video Mapping: This system integrates the user's image with 2D graphics.
- Head-Mounted Display (HMD): This display screen and speakers for audio output.
- Cave Virtual Environment: This is a small space prepared with projection screens on walls, floor, and ceiling, creating the perception (**Alzubaidy and Al-Tameemi, 2024**).
- Data Gloves: These gloves are equipped with sensors to distinguish materials and objects in terms of type, size, and temperature to enhance immersion and interaction.
- Arms and wands: Used to manipulate objects in the virtual environment.
- Data suit: Contains sensors throughout to transmit all of the person's movements to the virtual environment for a feeling of complete immersion.

3.6 Presence and Immersion as Cognitive Values

Presence can be defined as the psychological response to immersion, which is the psychological illusion of being within a virtual environment despite the physical awareness that one is in the real world. Five basic classifications of presence in virtual reality have emerged in the literature, which collectively represent the learner's experience in virtual reality, as follows (**Rubio-Tamayo et al., 2017**):



- Spatial Presence: This represents the user's feeling of physical presence within the virtual environment, where the intermediary (the real environment) is transcended, and the virtual digital space is perceived as reality. Spatial presence is optimized by two factors (**Li et al., 2025**): Augmenting the field of view (FOV) to increase immersion, Actual movement within the virtual environment.
- Social Presence: This represents the feeling of psychological connection with other users present within the same Immersive space, whether they are real or simulated, and the sense of their awareness and social engagement (**Hassan and Al-Alwan, 2026**).
- Co-presence: This represents the feeling of being in a multi-user platform in the same virtual place and time, and the awareness and interaction with them.
- Self-presence: This represents the extent to which the user is aware that their digital representation (avatar) is an extension of their real body. It is enhanced through the synchronization of movement between the body in reality and the avatar.
- Cognitive Presence: This represents the learner's ability to construct and form knowledge in the virtual environment.

Most studies rely on three approaches to measuring Presence in virtual reality educational environments (**Li et al., 2025**):

- 1) Subjective Measures: Through questionnaires, the most commonly used are:
 - IPQ (Igroup Presence Questionnaire): To measure realism and spatial presence.
 - Slater-Usch-Steed (SUS): To measure the feeling of being there.
 - NASA-TLX: To measure mental effort and its relationship to attendance.
- 2) Biometric Data: Through monitoring eye tracking to measure visual focus, heart Rate (HRV) to measure emotional arousal, and electroencephalography (EEG).
- 3) Performance Metrics: Through monitoring speed of task completion, number of errors, and accuracy of information retrieval after the session.

4. PRACTICAL FRAMEWORK

To answer the research question, it was Essential to validate the indicators for measuring the effectiveness of the educational process in the traditional environment and virtual reality. An experiment was implemented with a sample of 50 architecture students, classified into two groups:

The first group, comprising 25 students, received information about the Hagia Sophia Mosque in a traditional Protocol through a PowerPoint presentation shown in **Fig. 1** The second group, also composed of 25 students, received the information by virtual reality headsets (Meta Quest 2) for the same Mosque shown in **Fig. 2**. To make sure that both groups Collected the same information. The information in the PowerPoint lecture for the first group was specified only in the 360-degree video that was shown to the second group.

Since the duration of the virtual reality video is 8 minutes, the experiment was conducted for the two groups for a duration of 12 minutes, which included an introductory explanation of the purpose of the experiment and the method of conducting the survey after the experiment.

The virtual reality video was 8 minutes long. The experiment was conducted for Group A for 30 minutes, including an introductory explanation of the experiment's objective and how to conduct the post-experiment survey, along with a theoretical explanation that ran concurrently with the video being shown on a screen in the discussion and conference hall of the Department of Architectural Engineering at the University of Baghdad. Group B's experiment was conducted in the back of the studio and lasted approximately 3 hours, with

students taking turns, due to the availability of only one virtual reality headset, which prevented all students from participating simultaneously.



Figure 1. The traditional method



Figure 2. virtual reality method

4.1 Reasons for Choosing the Hagia Sophia Mosque for the Practical Test

After reviewing Various local and international buildings, the Hagia Sophia Mosque was selected as a case study for many reasons. First, a case with clearer formal legibility and less historical and symbolic complexity may have allowed students to distinguish spatial and architectural features more directly. In Architecture side, the building has a hybrid horizontal plan that integrates the rectangular basilica form with a square layout, and the massive dome stands on pendentive arches, given that the dome's loads are transferred through four Pendentives down to the square base below.

The vastness of its interior space Forcefully Expresses the Enormous scale of the building, as shown in **Fig. 3**. Finally, its international fame has established it as a tourist destination, and the availability of high-definition, professional VR footage makes it particularly well-suited for immersive virtual reality research and analysis.



Figure 3. Hagia Sophia Mosque



4.2 Data Collection

Data to measure student Presence was acquired through a Google Forms questionnaire. Also, by monitoring visual focus, body movement, and Active Recall after the session. This was achieved through questions asked directly and questions included in the survey form. To ensure the Accuracy and clarity of the questionnaire form, it was reviewed by an experienced university professor with over 25 years of experience in architectural education. The form was then edited based on his feedback.

4.3 Questionnaire Structure

Based on the theoretical framework, the questionnaire was designed to transform the theoretical concepts into measurable variables to evaluate virtual reality as a tool in architectural education. The questionnaire was intended to assess students' presence during the experience, as presence is regarded as one of the main outcomes of virtual reality learning. To achieve a comprehensive assessment, the questionnaire included items concerning spatial perception, understanding of the architectural content, and students' preferences concerning the educational method. The questionnaire, form by Google Forms, was designed at four parts and distributed via QR code. Closed-ended questions were used to collect data, with (yes/no) answers, MSQ answers, and selection of the Suitable answer from among five options according to a 5-point Likert Scale. Completion was Compulsory to ensure a comprehensive response. It consists of 4 parts, each of which aims to measure a specific point, as follows:

- In the first section, there is general participant information, such as gender, the presentation method (Metaquest2 VR headset, PPT presentation, or video presentation), and, if using Metaquest2, whether the participant had Previous experience with the headset and had visited the mosque before. This section aims to ensure equal participation from both genders of students across all academic levels. After completing the survey, participants can be grouped according to their presentation method, allowing for a comparison of reactions between those experiencing virtual reality for the first time and those who have experienced it before, specifically if they received the presentation via Meta Quest 2 VR headset.
- The second part included a practice test of the architectural information presented in the presentation to ensure the reliability of responses to parts three and four and to eliminate inconsistent or illogical answers.
- The third part of the questionnaire included questions to measure the spatial awareness of both groups.
- The fourth part included collecting student feedback on their preference for one of the two teaching methods. Responses of the third and fourth parts consisted of a 5-point Likert Scale: (strongly agree, agree, neutral, disagree, strongly disagree).

Each part will undergo statistical analysis, with a detailed explanation of the questions it contains and what it measures.

4.4 Questionnaire Design and Sampling

The questionnaire's QR code was allocated to Sampled from various academic years in architecture. These students were chosen to use purposive sampling, which is a non-probability sampling method. 10 students were selected from each academic year, recommended by their supervising instructor, considering their varying levels of



understanding. Then they were divided into two groups of 5 students each, numbering 50 students. In addition, in both groups, the students' understanding and responses were noted by asking them questions to match their answers on the questionnaire and ensure reliability. The students in the second group Concerning their experience, feelings, and the level of separation from noise. Among the 50 students, 45 answered the questionnaire, resulting in a 90% response rate. Furthermore, excluding 3 answers because the answers in the second part did not match the third and fourth parts, which means that their answers were illogical, the total number of reliable answers was 42 (84%), and this rate is considered statistically strong, and its results can be relied upon.

4.5 Results Analysis

Data were entered using SPSS and processed using frequency distributions and descriptive statistics. This technique provides a comprehensive and brief overview of the distribution of responses between the two groups. The study aims to find the differences between the two experiments through these questionnaire responses. Moreover, percentages and frequencies facilitate the sorting and identification of responses within the sample. This method is consistent with similar exploratory studies in architecture and other social sciences

First: Participant Data. Based on **Table 1**, the study population includes 42 students, who were divided into 18 males (42.8%) and 24 females (57.1%). This rate is considered close, and there is equilibrium between male and female respondents, which ensures fairness and reliability in the experiment. Concerning the presentation method used in the experiment, we note that the number of students is equivalent in both methods (21 students in each group), representing 50%. This rate represents a balance in applying the experiment using both methods to the same number of students, meaning that equal responses are obtained from both experiments. We note that the sample on which the experiment was conducted using virtual reality technology is divided into two groups in terms of their experience with this technology. We observe that 9 students have previous experience with technology (42.8%), and 12 of them are trying the technology for the first time (57.1%). These rates provide clear and accurate results in the third and fourth parts of the questionnaire.

Table 1. Participants' Data.

Variable	Attributes	repetition	Percentage %
Gender	Male	18	42.8
Presentation Method	Female	24	57.1
For the sample group that underwent the virtual reality presentation experiment, was there any prior experience with this technology? (21 students)	PowerPoint	21	50

Second: A practice test of the architectural information presented in the presentation. This section examines the reliability of the answers to parts 3 and 4, filtering out illogical responses. the information retrieval questions aim to measure the level of focus and presence within the learning environment. Based on **Table 2**, which represents the responses of the 21 students in the virtual reality learning group, and according to the frequency distribution of correct answers, we note that the total number of correct answers was 93, reflecting 88.57%. The results show that the virtual reality learning group achieved high results. The achievement rate for the first question was 85.7%, while the achievement



ratios of the second, third, and fourth questions were 95.2%. The fifth question achieved 71.4%, the lowest, as it required more focus. Computing the arithmetic mean of the students' scores according to the number of correct answers, we observe it to be 4.43 out of 5, which is the number of questions, considering one mark per question. Computing the standard deviation based on the frequency distribution leads to 0.72, less than 1, confirming the low dispersion in the results. These results support the validity of the research hypothesis that learning through virtual reality reduces individual differences between students' levels, as we observe a great convergence in the majority of the sample's scores.

Table 2. The responses of the students in the virtual reality learning group

Question	Answers	Frequency	Percentage %
What is the most prominent architectural feature of Hagia Sophia?	Pointed arches	1	4.7
	Large dome resting on pendentives (Pendentives)	18	85.7
	Multiple small domes	2	9.5
The relationship between the dome and the interior space	The dome is visually separated from the space	1	4.7
	The dome dominates and visually unifies the space	20	95.2
	The dome does not affect the perception of volume	0	0
Describe the interior space of Hagia Sophia	Low and fragmented space	1	4.7
	Narrow elongated space	0	0
	Largest covered interior space of its time	20	95.2
The function of spherical triangles in the design of Hagia Sophia	Reducing wall thickness	2	9.5
	Transferring the load from the dome to the columns	20	95.2
	Increasing the number of side openings	0	0
The relationship between the dome and light in the interior space	The dome blocks light	3	14.2
	Light enters only through the walls	3	14.2
	The dome's openings create a sense of lightness	15	71.4

According to **Table 3**, which represents the responses of the 21 students who participated in the PowerPoint presentation, and based on the frequency distribution of correct answers, we observe that the total number of correct answers out of the total number of responses was 93, representing 88.57%. The findings show that the PPT learning group attained high results. The response rate for the first question was 90.48%, while the response rates for the second and fourth questions were 95.2%, and the third question achieved 100%. The fifth question attained the lowest response rate at 61.9%, because of its greater emphasis on concentration. The mean of the students' scores, computed according to the number of correct answers, is 4.43 out of 5. The SD, calculated based on the frequency distribution, is 0.81, less than 1, confirming the low dispersion in the results.

**Table 3.** The responses of the students in the PowerPoint presentation learning group

Question	Answers	Frequency	Percentage %
What is the most prominent architectural feature of Hagia Sophia?	Pointed arches	1	4.7
	Large dome resting on pendentives (Pendentives)	19	90.4
	Multiple small domes	1	4.7
The relationship between the dome and the interior space	The dome is visually separated from the space	1	4.7
	The dome dominates and visually unifies the space	20	95.2
	The dome does not affect the perception of volume	0	0
Describe the interior space of Hagia Sophia	Low and fragmented space	0	0
	Narrow elongated space	0	0
	Largest covered interior space of its time	21	100
The function of spherical triangles in the design of Hagia Sophia	Reducing wall thickness	0	0
	Transferring the load from the dome to the columns	20	95.2
	Increasing the number of side openings	1	4.7
The relationship between the dome and light in the interior space	The dome blocks light	3	14.2
	Light enters only through the walls	5	23.8
	The dome's openings create a sense of lightness	13	61.9

Even though the mean values for groups were equal, there was a difference in standard deviation. The first group's standard deviation was 0.72, while the second group's standard deviation was 0.81. This gives the first group A slight lead in terms of minimizing the gap between student levels. As regards stability and reliability, the first group also showed greater consistency in the 5th question, with 15 correct answers, compared to the second group's 13 correct answers. This indicates that VR is slightly more effective than PPT in conveying complex information. Nevertheless, the second group showed a verified advantage in the third question, achieving 21 correct answers, and in the first question, achieving 19 correct answers. These results reflect a comprehensive view of the comparison between the two groups and confirm that the two groups are statistically equivalent. This indicates that any statistical differences in the third and fourth parts of the form represent only the type of teaching style and do not represent differences in the students' mental levels. Also, the answers to the questions in the third and fourth parts were compared with the answers to this part, and based on what was observed during the experiment on the students, 3 forms were excluded because they did not match the answers and were illogical.

Third: Measuring Student Engagement. This section of the questionnaire evaluates student engagement in VR technology by surveying students using the questions listed in **Tables 4 and 5**. It assesses the following:

- Question 1: Ability to identify architectural features
- Question 2: Ability to distinguish architectural elements
- Question 3: Perception of interior space dimensions
- Question 4: Ability to analyze the relationship between the dome and interior space
- Question 5: Focus and immersion without mental distraction



- Question 6: Ability to connect auditory and visual information
- Question 7: Motivation and interest

To examine the reliability of the questionnaire, the internal consistency of the 7 questions was assessed by Cronbach's alpha coefficient, with a value of 0.713, showing acceptable internal consistency.

According to the responses, the level of engagement for each student is evaluated, thus measuring the overall engagement level in both groups and comparing the differences between them. Based on **Table 4**, which measures the level of participation in the VR group, we note that the general trend of responses to the first question is towards the "I agree" answer, with 12 out of 21 responses, representing the largest percentage at 66% of the total responses. The Mean of 3.76 indicates success in identifying information. The standard deviation (SD) of 0.62 indicates the homogeneity of the responses. The first question achieved a participation rate of 75.2%, which is a very significant percentage, as it achieved three-quarters of the statistical potential for the question, Accounting for the presence of 7 neutral responses, meaning there is the probability of an increase in the percentage of agreement.

Regarding the second question, we observe that the general trend of responses is towards the "strongly agree" answer, with 12 out of 21 responses. The mean of 4.2 indicates success in characterizing architectural elements. Even though there is Variation between the two responses (I agree and strongly agree), the standard deviation (SD) of 0.68 confirms the lack of dispersion in the sample. The second question achieved a presence rate of 89.6%, which is considered high. In question three, while the "Strongly Agree" responses achieved the highest value (13 out of 21) and had a mean of 4.33, indicating an understanding of the dimensions of interior space, the standard deviation of 1.11 suggests a dispersion in the responses. We also observe the presence of "Disagree" and "Neutral" answers, which, although few, affected the Homogeneity of responses. This indicates individual differences, such as the ability to imagine or the feeling of dizziness during head movement while wearing Meta Quest 2. The Presence rate for Q3 was 86.6%, which is high despite the slight dispersion in the responses. In Q4, observe a Convergence between the "Agree" and "Strongly Agree" responses (8 and 9), which is due to the analytical nature of the question. The mean of 4.24 indicates success in analyzing relationships, and the standard deviation of 0.77 reinforces this result, demonstrating the homogeneity of the responses. The level reached, The Presence rate for question 84.8%, is considered high. Question 5 achieved "strongly agree" responses, with a mean of 4.57, indicating strong immersion. The standard deviation of 0.68 shows slight dispersion in the responses. The Presence level reached 91.4%, indicating the effectiveness of VR technology in achieving immersion. The general trend in responses to question 6 shows agreement, with 12 out of 21 responses. The mean of 4.24 indicates the ability to connect the information. This is the same as for Q4, and both questions are characterized by an analytical nature, which lends reliability to the responses. Moreover, the SD value 0.62 is the lowest among the questions, indicating high homogeneity in the responses. The Presence level reached 84.8%, which is considered high. Q7 recorded the highest "strongly agree" responses. 14 out of 21 students had the highest mean of 4.57, indicating student engagement and motivation. The SD value of 0.75 is relatively low, despite the "disagree" answer, due to the strong consistency of the responses. The student attained a very high Presence rate of 91.4%. According to the statistical analysis in **Table 4**, the Weighted Mean is 4.31, and the overall Presence rate is 86.2%, which is classified as very good.

**Table 4.** The Engagement, Attendance, and Recall for the PowerPoint Presentation Group

Question	Answers					Mean	Standard Deviation	Question Direction	Presence Level %
	Agree	strongly agree	neutral	disagree	strongly disagree				
I was able to identify the key architectural events that characterized each phase of Hagia Sophia's functional transformations.	11	5	5	0	0	4	0.77	Agree	80
I felt the presentation helped me distinguish fundamental architectural elements such as the dome, spherical triangles, columns, and interior space.	12	6	2	1	0	4	0.84	Agree	80
I felt I was able to appreciate the internal dimensions of the space (the dome's height, the hall's width, and the column arrangement).	7	3	6	4	1	3.33	1.15	Agree	66.6
I was able to grasp the relationship between the dome and the interior space and how it influenced the sense of openness and light.	10	6	5	0	0	4.05	0.74	Agree	81
I felt the presentation helped me focus and immerse myself in the content without distractions.	7	7	5	2	0	3.9	0.94	agree & strongly agree	78
I felt the presentation helped me connect theoretical information with the visual architecture of the building.	8	6	6	1	0	3.9	0.83	Agree	78
The presentation was scientifically stimulating and sparked my interest in continuing to learn about Byzantine architecture.	7	10	2	2	0	4.19		strongly agree	83.8
Overall Grade						3.91	0.89	agree	78.2

samples t-test was executed to compare students' Presence among the 2 groups. The results showed a statistically significant difference between them ($t = -2.827$, $p = 0.008$). Group B achieved a higher mean ($M = 14.71$) than Group A ($M = 11.7$), reflecting that the use of VR enhanced students' presence in the experience. These results support the research hypothesis.

Fourth: Teaching Method Preference. This section of the questionnaire explores the opinions of students in both groups regarding their preference for traditional teaching methods using PPT presentations versus virtual reality technology. The first question examines the effectiveness of VR in understanding space and architectural elements compared to traditional methods. The second question asks whether traditional presentations provide a clearer understanding of complex theoretical information. The third question indicates that VR stimulates interest and enhances engagement with the subject. The fourth question indicates that VR offers the closest experience to reality and Enriches information retention. The fifth question shows the preference for using VR in the study of heritage buildings. On



the other hand, the sixth question asks whether there is a greater preference for studying these subjects by traditional methods. Finally, the seventh question explores the students' preference for combining both methods in architectural education.

The internal consistency of the Teaching Method Preference was examined by Cronbach's alpha coefficient, with a value of 0.750, which indicates good internal consistency. Their responses were presented as shown in **Table 5**, which represents the responses of the VR group, and **Table 6**, which represents the responses of the PPT group.

Table 5. The Measured the preference for the teaching method for the virtual reality Group

Question	Answers					Mean	Standard Deviation	Question Direction	Presence Level%
	Agree	strongly agree	neutral	disagree	strongly disagree				
I feel that learning with virtual reality is more effective in understanding space and architectural elements compared to PowerPoint and video presentations	2	18	1	0	0	4.81	1.14	strongly agree	96.2
I find traditional presentations clearer for understanding detailed theoretical information and complex concepts.	2	2	10	4	3	2.76	0.98	neutral	55.2
I feel that learning with virtual reality makes me more interested and engaged in the subject.	4	14	1	1	0	4.43	0.5	strongly agree	88.6
I feel that the virtual reality method gives me a more realistic experience and helps me remember information better.	10	11	0	0	0	4.52	0.6	strongly agree	90.4
If I had the opportunity, I would like to study similar historical or architectural topics using virtual reality.	8	12	0	0	0	4.52	1.02	strongly agree	90.4
I prefer using traditional presentations for studying theoretical or historical material because it is faster and easier to review.	7	3	5	6	0	3.33	0.8	disagree	66.6
I believe that combining virtual reality with traditional lectures would be the best way to learn	3	16	1	1	0	4.62	1.14	strongly agree	92.4

According to the statistical analysis of the responses, the following was revealed: As stated in **Table 5**, which shows the opinions of the VR group, the responses to the 1st Q showed strong agreement, with 18 out of 21 responses agreeing. This constitutes a relative 96.2%, which is excellent. Note the mean value of 4.81 and the SD of 0.51. This indicates a high preference for using virtual reality technology to construct spaces and architectural elements. The answers to the 2nd Q tend towards neutral, with several 10s achieving a relative 55.2%, which is acceptable but weak. Note the value of the mean 2.76 and the SD value 1.14, which indicates a high dispersion in the sample's answers. This indicates a preference for the VR technology method. The answers to the 3rd Q validate the Accuracy of the 2nd Q analysis, as we note the trend of answers towards strong agreement with several 14, and achieving a relative 88.6%, which is very good compared to the 2nd Q, which is the opposite. The mean value 4.43, and the SD is 0.98, which is high but does not exceed 1. This Deviation because of two answers, one of neutrality and the other of disagreement, and four answers of agreement, which does not represent a lack of homogeneity. Q4 achieved a relative 90.4%, an excellent result. We observe a trend towards strong agreement with 11



responses and agreement with 10 responses. The mean value was 4.52, with an SD value of 0.5, a low rate that refers to preference for the experience. Equally, Q 5 showed a trend towards strong agreement with 12 responses, and a relative 90.4, which is excellent. The mean value 4.52, and the SD value was 0.6, confirming the preference for VR technology. To validate this preference, the question was rephrased, expressing a preference for the PPT method. The relative was 66.6%, which is acceptable. Nevertheless, the distribution of responses was split between agreement (7) and disagreement (6), resulting in a dispersion value of 1.02, which is high. Q7 had a relative value of 92.4%, and the responses marked a preference for combining VR and PPT teaching methods in the Educational Paradigm. Three responses were in agreement, with a mean value of 4.62 and an SD value of 0.8. While relatively high, this is justified by the fact that only two responses fell into the neutral category, meaning they did not affect the homogeneity. According to the statistical analysis of **Table 5**, the results show a preference for VR technology more than the PPT methods, and a preference for combining the two.

Analyzing **Table 6**, which summarizes the opinions of the PPT group, observe that the responses to the 1st Q were split between strongly agreeing and agreeing, with 8 responses in each. This resulted in a relative 82%, which is very good. The mean value was 4.1, and the SD value was 0.89, which is high. This is ascribed to the dispersion of responses between neutral and disagreeing (5 responses). Nevertheless, this does not affect the homogeneity of the sample, given the majority's inclination towards agree, indicating a high preference for using VR technology to perceive spaces and architectural elements. The 2nd Q achieved 11 neutral responses, and a relative 62.8%, which is acceptable. The mean value was 3.14, and the SD value was 0.96. The responses indicated a negative trend, indicating a preference for the VR technology method. The answers to the 3rd Q confirm the validity of the 2nd Q. Observe a trend towards strong agreement with 12 responses, and a relative 88.6%, which is very good compared to the 2nd Q. Note the mean value 4.43 and the SD value 0.81. This dispersion is due to two responses: one neutral and the other disagreeing, and 7 agreeing responses. This does not represent a heterogeneity of the sample, and we observe a similar percentage of responses to this question in both groups. In a similar vein, the 4th Q attained a relative 84.8%, which is a very good percentage. Observe a trend towards strong agreement with 10 responses and agreement with 7 responses, reflecting a close percentage between them. The mean value is 4.24, with an SD value of 0.89, which is high due to the dispersion of 4 responses between neutral and disagreeing, but it does not affect the homogeneity of the sample since the majority of responses were between agreement and strong agreement. This refers to acceptance and preference for the experiment. Similarly, in Q5, a trend towards agreement was observed with 10 responses and a relative 83.8%, which is very good. The mean value was 4.19 and the SD value 0.81, validating their preference for using VR instead of PPT. To reinforce this acceptance, the question was rephrased in the form of a preference for the PPT method, resulting in a relative of 69.6%, which is acceptable. The trend towards agreement was 9 responses, with a mean value of 3.48 and an SD value of 0.87. Q7 relative was 88.6%, and the responses trended towards agreement concerning the integration of VR and PPT methods in the educational process. Three responses agreed, with a mean value of 4.43 and an SD value of 0.81, which is high, but justified because there were only two responses in the neutral category, meaning they did not affect the homogeneity of the sample. According to the statistical analysis of **Table 7**, the results reflect a preference for the VR over the PPT method. also find that there is a preference for combining the two methods, as is the case in the first group.

**Table 6.** The Measured the preference for the PowerPoint teaching method

Question	Answers					Mean	Standard Deviation	Question Direction	Presence Level %
	Agree	strongly agree	neutral	disagree	strongly disagree				
I feel that learning with virtual reality is more effective in understanding space and architectural elements compared to PowerPoint and video presentations.	8	8	4	1	0	4.1	0.89	agree & strongly agree	82
I find the traditional presentation method clearer for understanding detailed theoretical information and complex concepts.	2	3	11	5	0	3.14	0.96	neutral	62.8
I find that learning with virtual reality makes me more interested and engaged in the subject.	7	12	1	1	0	4.43	0.81	strongly agree	88.6
I find that the virtual reality method gives me a more realistic experience and helps me remember information better.	7	10	3	1	0	4.24	0.89	strongly agree	84.8
If I had the opportunity, I would like to study similar historical or architectural topics using virtual reality.	10	8	2	1	0	4.19	0.81	agree	83.8
I prefer using the traditional presentation method for studying theoretical or historical material because it is faster and easier to review.	9	2	7	3	0	3.48	0.87	agree	69.6
I believe that combining virtual reality with traditional lectures would be the best way to learn	7	12	1	1	0	4.43	0.81	strongly agree	88.6

By comparing the results of the two methods, observe that preference for VR is higher than PPT in both groups, with close percentages for the responses of the two groups. Also note that both groups preferred and recommended combining the two methods in the field of architectural education.

5. RELIABILITY TESTING RESULTS

A t-test was conducted on both groups to enhance the reliability of the results. The results of the cognitive performance test for the presented architectural information showed that both groups achieved the same mean score of 4.43. This shows that VR is more effective than the traditional method of displaying information, with homogeneity in the VR group indicated by the SD of 0.72, while the PowerPoint group recorded 0.81. The presence and perception test for both groups showed a t- test of 1.57, which is normal due to the small sample size. Despite this, the effect size was recorded as 0.48, which indicates a significant effect. This confirms that the differences in the mean score between the two groups resulted from the change in presentation method. VR reached a mean score of 4.33, while the PowerPoint group's mean score decreased by a full point to 3.33. This difference compensates for the small sample size. Furthermore, the standard deviations, which were mostly less than 1 in the VR group, confirm the homogeneity of the responses. Furthermore,



the use of the reversed questioning method in the survey provided high reliability and consistency of the responses. Regarding the preference for teaching methods, the results were consistent in both groups, with students unanimously agreeing on the superiority of virtual reality technology in achieving immersion and understanding spatial relationships, with average scores peaking at 4.81 and a low standard deviation confirming the homogeneity of opinion, thus giving the analysis high reliability.

6. CONCLUSIONS

Based on the statistical results, this study rigorously explored the Capability of immersive learning using virtual reality technology to afford a learning environment that meets the needs of the new generation. The findings are consistent with previous studies emphasizing the educational value of virtual reality in enhancing students' presence, engagement, and experiential learning. VR was indicated to be effective since group B attained significantly higher scores on presence and learning experience than group A. The study confirmed what previous studies had suggested regarding the effectiveness of integrating virtual reality into architectural education, as it improves students' presence, immersion, spatial perception, and information retention compared with traditional methods. This is even more evident in student preferences for a mixed learning method. On the other hand, the main limitations of VR include device readiness, shared-use risks, user negative effects, and the necessity of training teaching staff. The study also showed the requirement for adjustable architectural learning spaces designed to accommodate the effective integration of VR technology. It is recommended that curricula in architectural education incorporate virtual experiences supported by laboratories provided with the infrastructure and technologies for VR-based learning, adopting a mixed learning model that blends traditional teaching with VR methods, especially for subjects need imagination and practical experience. With defining appropriate time limits for VR experiences to minimize negative effects. Despite the positive results, they should be interpreted in light of the study's limitations. Because the experiment involved architecture students at the University of Baghdad through a purposive sample, the findings cannot be generalized to all architecture colleges in Iraq due to the specific characteristics and capabilities of each institution. Nevertheless, these results provide empirical evidence of the effectiveness of virtual reality in architecture education in Iraq and lay a foundation for future research.

NOMENCLATURE

Symbol	Description	Symbol	Description
VR	Virtual Reality	t	t-test
M	Mean	Q	Question
SD	Standard Deviation	PPT	Power Point

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Credit Authorship Contribution Statement

Qamar Jamal Saleem: draft writing, validation, methodology, and proofreading. Saad Fawzi Tuama: Writing –review & editing.



Declaration of Competing Interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

REFERENCES

Abdul-Jabbar, S.N. and Alwehab, A., 2023. Augmented reality's role in highlighting historical heritage/Kirkuk Citadel. *Journal of Engineering*, 29(12), pp. 104–122. <https://doi.org/10.31026/j.eng.2023.12.07>.

Abdul-Wahid, Z.R., 2022. Digital learning technology and the rehabilitation of Iraqi school buildings. Master's thesis, University of Baghdad, Department of Architecture.

Alayouia, H., 2014. Social sciences between traditional and contemporary teaching: A study of the reality of social sciences in the Algerian university. PhD thesis, Department of Sociology, University of Oran.

Al-Jumaili, S.K.M., 2012. The effect of organizing the university environment on increasing its efficiency and directing economic resources. *Journal of Planning and Development*, (25).

Alzubaidy, D.M. and Al-Tameemi, O.A.M., 2024. Evaluating the perception of virtual reality in historical sites. *BIO Web of Conferences*, 97, Article 00082. <https://doi.org/10.1051/bioconf/20249700082>.

Al-Zubaidi, D.M.F., 2024. The role of modern digital techniques in the preventive conservation of historical buildings in Iraq: Taq Kasra-A case study. Master's thesis, Department of Architecture, University of Baghdad.

Aydın, S. and Aktaş, B., 2020. Developing an integrated VR infrastructure in architectural design education. *Frontiers in Robotics and AI*, 7, P. 495468. <https://doi.org/10.3389/frobt.2020.495468>.

Cardona Reyes, H., Lara-Alvarez, C., Parra-González, E.F. and Villalba-Condori, K., 2023a. Virtual tours to facilities for educational purposes: A review. *TEM Journal*, 12(3), pp.1667–1675. <https://doi.org/10.18421/TEM123-55>.

Coolsaet, D., 2024. The impact of technological advancements on higher education: A study of Generation Alpha's educational prospects. *International Journal Software Engineering and Computer Science (IJSECS)*, 4(1), pp. 58–67. <https://doi.org/10.35870/ijsecs.v4i1.2147>.

Díaz González, E.M., Belaroussi, R., Soto-Martín, O., Acosta, M. and Martin-Gutiérrez, J., 2025. Effect of interactive virtual reality on the teaching of conceptual design in engineering and architecture fields. *Applied Sciences*, 15(8), P. 4205. <https://doi.org/10.3390/app15084205>.

Erita, Y., Miaz, Y., Jupriani, J., Hevria, S. and Fauzi, R., 2024. Using virtual reality to enhance twenty-first-century skills in elementary school students: A systematic literature review. *Open Education Studies*, 6(1), P. 20240030. <https://doi.org/10.1515/edu-2024-0030>.

Fadhil, A., 2015. Architecture of higher education and the impact of the age "Learning-Friendly Campus". Master's thesis, Department of Architecture, University of Baghdad. <https://doi.org/10.13140/RG.2.2.21175.59042>.

Hamza, S.M., 2020. The role of collective memory in architectural education. PhD thesis, Department of Architecture, University of Technology.



- Hashim, W.H., Nouri, O.G. and Marzouk, R.H., 2023. Digital modeling and its technical variables in contemporary interior design. *Al-Academy Journal*, (109), pp. 323–342. <https://doi.org/10.35560/jcofarts1249>.
- Hassan, S.K. and Al-Alwan, H.A.S., 2026. Children's perception and learning skills: Implications in kindergarten architecture. *Journal of Engineering*, 32(1), pp.72–89. <https://doi.org/10.31026/j.eng.2026.01.06>.
- Höfrová, A., Balidemaj, V. and Small, M.A., 2024. A systematic literature review of education for Generation Alpha. *Discover Education*, 3(1), P. 218. <https://doi.org/10.1007/s44217-024-00218-3>.
- Jumaah, F.R., 2023. Internationalization of architectural education (Department of Architectural Engineering/ Al-Nahrain University as a model). Master's thesis, Al-Nahrain University.
- Lafta, R.S., 2019. Virtual reality applications in the interior design of smart buildings. *Journal of Social Sciences and Humanities Studies*, 46(2), University of Baghdad, College of fine Arts.
- Lara-Alvarez, C., Parra-González, E.F., Ortiz-Esparza, M.A. and Cardona Reyes, H., 2023b. Effectiveness of virtual reality in elementary school: A meta-analysis of controlled studies. *Contemporary Educational Technology*, 15(4), P. ep459. <https://doi.org/10.30935/cedtech/13569>.
- Li, J., Wu, T., Zhao, H. and Xu, X., 2025. How to enhance the interpretability of learning-based motion planning for intelligent vehicles—A survey. *IEEE Transactions on Intelligent Transportation Systems*, pp.1–22. <https://doi.org/10.1109/TITS.2025.3558958>.
- Malhotra, G., 2015. Relevance of technology in teachers' learning and teaching. Centre for Communication Studies, Jagannath International Management School. https://www.researchgate.net/publication/339587277_Relevance_of_technology_in_teachers'_learning_and_teaching
- Mathur, T. and Shrivastava, N.P., 2020. Augmented reality and virtual reality in the field of education. *International Research Journal of Engineering and Technology (IRJET)*, 7(6), pp. 5581–5584.
- Muppudathi, G., 2014. Technology in teaching and learning. In: Paper presentation, Tamil University, Department of Education, India, 13–14 March 2014.
- Mystakidis, S. and Lympouridis, V., 2023. *Immersive learning*. *Encyclopedia*, 3(2), pp.396–405. <https://doi.org/10.3390/encyclopedia3020026>.
- O'Regan, T., 2000. Review: Don Tapscott, Growing up digital: The rise of the net generation. *Media International Australia*, 94(1), pp. 177–178. <https://doi.org/10.1177/1329878X0009400133>.
- Prensky, M., 2001. Digital natives, digital immigrants part 1. *On the Horizon*, 9(5), pp. 1–6. <https://doi.org/10.1108/10748120110424816>.
- Ramlee, M. and Kashefian-Naeeni, S., 2017. Moving teaching and learning into the digital era. *International Journal of English Language & Translation Studies*, 5(3), pp. 27–36.
- Rami, Z., 2022. *Digital learning technology and the rehabilitation of Iraqi school buildings [Master's thesis, University of Baghdad]*.
- Revathi, A.R. and Shwetha, M., 2019. Digital learning. *CSI Communications*, 43(4), pp. 11–13.



Rowe, D., 2002. Environmental literacy and sustainability as core requirements: Success stories and models. In W. Leal Filho (Ed.), *Teaching sustainability at universities: Towards curriculum greening* (pp. 79–103). Peter Lang.

Rubio-Tamayo, J.L., Gértrudix, M. and García, F., 2017. Immersive environments and virtual reality: Systematic review and advances in communication, interaction and simulation. *Multimodal Technologies and Interaction*, 1(4), P. 21. <https://doi.org/10.3390/mti1040021>.

Rzqoo, N.J., 2020. Quality in engineering education: exploring the weaknesses in the quality of the academic program – A review. *International Research Journal of Engineering and Technology (IRJET)*, 7(12).

Sherman, W.R. and Craig, A.B., 2002. *Understanding virtual reality: Interface, application, and design*. Morgan Kaufmann (Book) 1st edition.

Ziatdinov, R. and Cilliers, E.J., 2021. Generation Alpha: Understanding the next cohort of university students. *European Journal of Contemporary Education*, 10(3), pp. 783–789. <https://doi.org/10.13187/ejced.2021.3.783>.

التعلم التفاعلي: دراسة مقارنة لحضور طلاب الهندسة المعمارية بين الواقع الافتراضي وبيئات التعلم التقليدية

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الخلاصة

أدى دمج الواقع الافتراضي في التعليم المعماري إلى زيادة الحاجة لتقييم فعاليته وتأثيره محلياً. يهدف هذا البحث إلى قياس فعالية الواقع الافتراضي في التعليم المعماري المحلي من حيث حضور الطلاب وتجربتهم التعليمية، وتحديد القيود ضمن نطاق دراسة الحالة، والتأكيد على المجالات التي تحتاج إلى تحسين. وقد طُرح سؤال البحث (إلى أي مدى يُمكن للواقع الافتراضي تعزيز حضور طلاب الهندسة المعمارية وتجربتهم التعليمية، مع الأخذ في الاعتبار بيانات الوضع الراهن في العراق؟)، كما طُرحت الفرضية التالية: التعلم من خلال الواقع الافتراضي يُعزز حضور الطلاب أكثر من الطرق التقليدية. ويعتمد البحث على منهجية مقارنة مختلطة، تشمل مرحلة نظرية لتطوير مؤشرات التقييم، ومرحلة تجريبية باستخدام المنهج المقارن، حيث قُسم طلاب الهندسة المعمارية إلى مجموعتين: (أ) تلقت تعليمها بالطرق التقليدية، و(ب) تلقت تعليمها من خلال الواقع الافتراضي. أظهرت النتائج أن التعلم من خلال الواقع الافتراضي عزز الحضور مقارنةً بالطرق التقليدية. وقد بلغ متوسط الحضور في المجموعة (ب) 4.33، بينما بلغ في المجموعة (أ) 3.33، مما يشير إلى وجود تباين بين منهجي التعلم. بالإضافة إلى ذلك، أبدى كلا الفريقين تفضيلاً لدمج الواقع الافتراضي، بمتوسط تقييم بلغ 4.81. كما حدد البحث تحديات الدمج، بما في ذلك الجاهزية التقنية وإدارة المشكلات المتعلقة بالمستخدمين. وأوصت هذه الدراسة، في الختام، بأن تتضمن مناهج التعليم المعماري تجارب افتراضية مدعومة بمختبرات مزودة بالبنية التحتية والتقنيات اللازمة للتعلم القائم على الواقع الافتراضي، مع اعتماد نموذج تعليمي مختلط يجمع بين أساليب التدريس التقليدية وأساليب الواقع الافتراضي.

الكلمات المفتاحية: التعليم المعماري، التعليم التفاعلي، الإدراك، الحضور المكاني، الواقع الافتراضي.