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Virtual Reality Technology in Architectural Theory Learning: An Experiment on the Module of History of Architecture

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Abstract: The purpose of this study is to determine the significance of incorporating virtual reality (VR) technology as an additional learning aid in the delivery of architectural theory modules. The aim is to expand students' horizons by utilizing VR as an immersive blended learning resource, particularly after the COVID-19 epidemic pandemic and the emergent need for new ways of delivering higher education. Empirical samples were drawn from a group of participating students in the History of Architecture module. This study adopted a mixed-methods approach comprising a quantitative inquiry (n = 60), which was complemented by a qualitative focus group discussion (n = 15). For the quantitative inquiry, three activities created virtual environments for three instances of Christian churches and cathedrals from the History of Christian Architecture: Hagia Sofia Cathedral, Notre Dame Cathedral, and Santa Maria del Fiore Cathedral. This was conducted during a 13-week teaching semester, with two groups of students voluntarily taking part in each activity: a VR group and a non-VR group. Following each activity, both groups responded to the same set of questions in order to assess the impact of using VR technologies on students' cognitive and analytical understanding of the related building. A focus group was formed with the participating students to enhance their understanding of the results of the quantitative inquiry. The findings of the research show an increase in student learning experience and knowledge recollection when using VR in comparison to conventional teaching methods. The findings emphasize the role of digital technologies in enhancing students' learning experiences, in particular, as a tool for sustainable approaches to teaching. This research expands knowledge and understanding about the use of VR in the History of Architecture pedagogy by examining its effectiveness as a medium of instruction. Furthermore, this study provides recommendations for adopting and incorporating new technologies in higher education for a better learning environment.

Keywords: higher education; student experience; virtual reality technology; architectural education; history of architecture; sustainable education

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1. Introduction

In recent years, and particularly in response to the COVID-19 pandemic, the higher education (HE) sector has witnessed significant shifts in teaching delivery methods. To ensure the continuity and consistency of the teaching and learning systems, HE institutions turned to online communication platforms, directing all tutors and students to engage in the learning process remotely [1]. This sudden and fast development left the HE field facing some critical challenges. The pandemic education phase resulted in some permanent changes to HE learning, with an increase in asynchronous learning, where students are provided with materials to learn independently from tutors' presence for the delivery of information, away from the typical classroom setting. Moreover, with the use of a mix of synchronous and asynchronous learning methods, 'blended learning' has also emerged and gained widespread popularity due to its capability to enrich student learning experiences. Blended learning, as it implies, refers to combining two or more learning methods on the

same module for the same group of students, usually the typical in-person classes and either synchronous or asynchronous remote learning activities [2]. This concept of blended learning has been around for over 15 years and is increasingly proving beneficial from a pedagogical point of view [3]. Students' involvement in asynchronous learning activities can improve their competence levels as they become in charge of their own learning process, which in turn contributes to an enhanced, personalized, and more enjoyable education experience [4].

In an era where the world is increasingly facing global warming and climate change challenges, sustainable ways of performing tasks in every field of life are becoming more urgent than ever [5]. The post-pandemic learning approach is, therefore, a great opportunity to contribute towards achieving sustainability. Sustainability as a concept is a future-oriented approach that ensures fulfilling current global demands without compromising future generations' availability of resources to fulfill their own needs. This requires a general lifestyle transformation in which individuals and societies adopt a wider view of attitudes towards global issues. The role of education hence becomes of significant importance, where sustainability is integrated into the educational process rather than being a stand-alone module or course. Sustainable education, therefore, arises as a learning approach in which the entirety of the educational process is sustainable [6]. Accordingly, developing a sustainable educational approach that prepares and empowers learners' capabilities to address global issues is crucial to providing a global transformative experience [7]. Such an approach should be incorporated on both an individual as well as an organizational level in order to foster progression towards sustainable development. Achieving this objective necessitates the implementation of a comprehensive strategy that includes deliberate educational planning and the facilitation of information transfer. Alternative learning techniques are therefore required to support and enhance student experience from a social inclusion perspective while, for instance, reducing the environmental footprint of the techniques used. Conversely, the field of education has been significantly transformed by advanced technologies, such as virtual reality (VR) [8].

2. Student Experience in Higher Education

The conventional approach to teaching and learning in HE comprises huge groups of students sitting in rows with little interactivity. This may create a passive experience, thereby failing to meet the learner's needs [9].

In the field of the built environment, blended learning has been explored to understand its efficacy as well as establish the most appropriate tools required to achieve better learning outcomes [10]. This has become even more necessary in view of the pressure to adapt in order to cope with increasing student numbers and also to meet the demands of an evolving construction industry where technological advancement has become commonplace [11].

In this study, the History of Architecture module is explored as a case study of blended learning. Currently, students consider a history class in the form of long PowerPoint (PPT) presentations consisting of slides and photos as uninteresting and unimportant in their architectural education. History learning is usually associated with memorization, which is a learning method that follows a standard and monotonous approach [12]. However, learning history in the context of architecture needs to be understood independently from learning History of Art in arts and design schools. History of Architecture students are normally expected to visually analyze and synthesize the spatial properties of historical elements and structures using architectural drawings, as well as develop familiarity with historical eras, events, key people, and related architectural styles. This is fundamentally due to the unique nature of architecture as a profession, where the main language of communication is architectural drawings, e.g., plans and spatial perspectives [13].

VR provides a new paradigm of interactive learning and engages architecture students in a more immersive way. In particular, VR is a viable alternative to physical visits to historic sites. It can help experience and better comprehend the nature, scale significance, details, and elements of these historical sites, as well as preserve their heritage [12]. However,

despite the potential significance of VR technology in understanding historical structures, concerns about the effectiveness of teaching history in the virtual world arise. Moreover, the feasibility of incorporating VR into the learning environment in the face of technological hurdles could be a barrier in the way of meeting the educational objective of teaching history in the context of architecture [14]. Nonetheless, VR can be used by tutors to support and complement typical classroom lectures and help students enrich and strengthen the course learning outcomes. However, despite the acknowledged promise of VR, its adoption in the field of education remains limited by the lack of simple platforms that enable education providers and students to generate VR experiences [15].

Student Experience

In light of rapidly evolving technological and digital innovation, preparing students to be highly adaptable intellectuals becomes of increasing importance. Such flexibility to continuously develop their skills, knowledge, and understanding enables students to address the constantly evolving demands resulting from advancements in digital technologies [16].

In this changing digital era, learning is more of a lifelong process in which students require up-to-date knowledge, skills, and information, as well as new learning techniques, in order to progress, contribute, and flourish. Current and future generations brought up in the era of technological advancements have high literacy in a wide variety of technologies, making them well-equipped for their HE journey. In fact, research shows that students of the twenty-first century are engaged in interactivity, multimedia, and social networking as part of their everyday experience and have been referred to as 'digital natives' or the 'net generation' [17].

Students' e-learning experiences in HE assist lecturers and university administrators in understanding how e-learning delivery can be designed and integrated better. Based on current worldwide research, the way students understand task requirements significantly impacts learning outcomes, and such interpretations are influenced by how delivery is designed and the tools used [18]. A comprehensive understanding is required to effectively design and manage modern learning environments. An ecological understanding must, however, recognize learners' agency as active interpreters of their environment and its culture, values, and challenges [18]. The importance of improving students' experience in HE has been recognized by academic institutions as a significant priority. Universities demonstrate their dedication to fostering a comprehensive array of student services and activities in order to effectively attract and retain a varied and competent enrollment. This commitment contributes to universities' sustainable global stand of promoting fairness, accessibility, and inclusivity in HE [19].

3. The Role of Technology in Architectural Education

The evolution of computing has been a primary driver of architectural education over several decades, resulting in the introduction and adoption of various computer-aided courses. These developments have often been introduced to help with the efficiency of tasks, including time and effort savings. However, architecture students have been reported to over-rely on this software, which often limits their creativity [20]. Nonetheless, mere reduction in the use of technology may not lead to any desirable outcomes. Instead, there needs to be investigations to identify how and which technologies do not stifle creativity and also, at the same time, have benefits related to efficiency. The limited knowledge concerning the usage of technology in architectural education that we could uncover and link to a wide range of information should prompt a reconsideration of how to build a new method of learning in architectural education [21]. Accordingly, the gap between architectural education and digital technology needs to be filled [22].

3.1. Virtual Reality Technology (VR)

As a result of the global pandemic, the adoption of VR has risen dramatically, leading to its emergence as one of the foremost information and communication technologies (ICT)

in educational reforms [23]. With growing significance for enhancing education quality, VR represents a technological innovation with significant potential [24]. VR is also an effective mode of communication, where students and educators can collaborate over long distances using a networked virtual world as a collaborative space [25]. As the VR medium matures, different persons and groups of people have diverse views and points of view about what it entails [26]. Several studies have classified VR into three categories: (tele-) presence, interactivity, and immersion. Presence is commonly defined as the sensation of being physically somewhere other than where one is. Interactivity affects the presence and relates to how much users may change their virtual environment in real-time [27]. Immersion is defined as the user being immersed in another, alternate reality [26].

3.1.1. Virtual Reality in Education

Along with gaming and entertainment, VR is increasingly being used in education, often for business training, as well as for university students and schools to some extent [28]. The significance of implementing VR technology into the educational process lies in enabling a rich immersive experience that is challenging to achieve using conventional teaching methods. VR provides learners with the opportunity to better understand and tackle complex situations that would otherwise be limited; for instance, it allows for immersion in virtual fields, limiting the need for physical visits and consequently enhancing the overall student experience. Furthermore, VR provides facilitators and education providers with the means to adapt information based on individual differences and learning needs [24]. Numerous businesses have emerged, including VR Immersive Education and Google Expeditions, which have begun to offer VR applications for use in the classroom, covering subjects such as anatomy, geography, history, physics, and chemistry. New Zealand's Correspondence School now offers classical studies in VR. Students can then navigate the virtual worlds to obtain relevant knowledge about the architecture of places [28].

Adjustments in educational techniques include utilizing virtual interactivity to shift the mode of teachers speaking on stage and students sitting in their seats, allowing teachers and students to study together in an integral and immersive manner. Using virtual technology to replace the traditional teaching style and visualization approaches to make the original complex and abstract concepts more intuitive, consequently enhancing the teaching effectiveness [29], the teacher can apply VR technology to guide students on a topic as well as share other ideas, which can aid their own creativity and self-exploration [30]. Additionally, VR has the potential to recreate simulations, situations, and locations where a real-life experience would be unfavorable, allowing for risk-free knowledge gain within the boundaries of the classroom [24].

3.1.2. Virtual Reality as a Contributor to the Education of History in Architecture

In architectural education, theory-based subjects such as the History of Architecture fail to inspire sufficient student enthusiasm. Students are expected to remember a large quantity of factual information, which makes the process daunting. The process of remembering information requires a comprehensive grasp of prior occurrences, and this is more efficient in immersive experiences [31]. VR is therefore promising in architectural history courses as it can provide immersion, contributing to a better engagement of senses and thereby making learning more enjoyable [32].

VR is therefore becoming increasingly important in educational technology in architectural history. A 360-degree view of any architectural information, in fact, gives students a genuine nearer reality experience and allows them to study their courses in great depth. A thorough depiction of the historical place is the greatest technique to build awareness of historical perspective and gain a deeper grasp of the subject. Hence, one of the benefits of VR is full immersion in a historical moment, where students may examine architectural elements up close, similar to a real-life city tour [33]. It is also an opportunity for students to save time and money on real-life tours, which may be in faraway places or even overseas.

Field trips are frequently used as an educational tool in architecture schools; most of the time, students will go to view historical or modern structures for a human-scale experience. However, with the increasing awareness of the potential of VR in delivering near-real experiences, many architecture schools nowadays use the technology. Table 1 provides instances of universities that have begun experimenting with VR in the classroom [12].

Table 1. Examples of universities experimenting with virtual reality in the classroom [12].

University	VR Methodology
Georgia State University	Art history course using virtual reality to see inaccessible architectural historical places with Google Cardboard
University of South California	Applying alternative methodologies for real-time computational representation of architectural design: VR and gaming engines
The Chinese History of Hong Kong	Utilizing VR technology to improve pupils' comprehension of Hong Kong's colonial architecture
Florida State University	Using Google Cardboard VR glasses to experiment with a virtual art history learning environment.

Additionally, despite previous studies providing essential insights into VR use in architecture education, no attention was given to the learners' views and levels of satisfaction, especially in the context of history in architecture. Therefore, the purpose of this study is to explore the potential benefits of incorporating VR technology into the learning of architectural theory modules as a sustainable teaching tool. This study aims to explore if and how the History of Architecture students' use of VR enhances their learning experience in light of an increased blended learning approach to the delivery process, with a particular focus on user experience and level of satisfaction.

4. Materials and Methods

This study was completed over the course of 13 weeks of full-time study of the History of Architecture module with undergraduate architecture students. In an introductory lecture, the learning outcomes and the main topics to be covered were clarified. The module structure was based on three hours of student-lecturer weekly contact: two face-to-face lectures and one online lecture activity. Students explored an e-learning platform, Moodle, where all the resources and activities completed during the course were stored. The uploaded resources included videos, photos, and VR applications as new educational tools that were introduced for improving student learning outcomes. Weekly evaluations and discussions of these activities were carried out during the face-to-face sessions. Table 2 provides the three activities employing both VR and traditional approaches (non-VR) to teaching throughout the semester, with two student groups randomly selected for each activity. All participating students were enrolled in the History of Architecture module in which they voluntarily participated in the three activities. Each activity was tackled by the two groups (VR and non-VR). The non-VR group was limited to traditional learning tools, i.e., presentations of architectural drawings and images using PowerPoint slides. Both groups, however, completed the same set of questions in a post-study evaluation. An additional qualitative inquiry was conducted to improve the validity and reliability of the findings in a mixed-methods design [34]. The qualitative inquiry was achieved through a focus group discussion at the end of the semester. The following table summarizes the different phases of the study as well as sample sizes.

Table 2. Sample size and timeframe of the methods.

	Quantitative						Qualitative
	Weeks 1–12						Week 13
	Activity 1		Activity 2		Activity 3		Focus Groups
	VR	No-VR	VR	Non-VR	VR	Non-VR	
Sample size	10	10	10	10	10	10	15

4.1. Quantitative Approach—Activities Evaluation

Students were informed that the results of these three activities would also be utilized for research and that participation was voluntary. The first activity related to studies on the Hagia Sofia church with the VR group (n = 10), using the VR, was a 360-degree tour of the Hagia Sofia church as illustrated in Figure 1 [35], and the non-VR group (n = 10) used 2D images and drawings. The second activity was based on the Notre Dame Cathedral, and the third activity was based on studies on the Santa Maria del Fiore Cathedral, following the same procedure as discussed in Activity 1. All three activities concluded with a post-evaluation questionnaire consisting of five binary questions about the architectural features of the relevant buildings. For each activity, the post-evaluation questionnaire was identical for both groups. The questions asked were both architectural and structural. These questions were derived from architectural elements characterizing historical buildings as conceptualized by architectural history authors [36,37]. The students were evaluated quantitatively one week after each activity based on the number of correct responses at each stage. Students were informed of their performance after each evaluation. SPSS was used to evaluate the descriptive statistics and ascertain central measures of tendency in the performance scores.



Figure 1. Hagia Sofia Cathedral via a VR 360-degree tour [35].

4.2. Qualitative Approach—The Focus Group

To confirm the reliability of the outcomes of the quantitative analysis, a focused group discussion was conducted with (n = 15) students to gain a deeper understanding of the students and their ability to develop and employ new learning methods that are

distinct from the traditional and widely accepted methods. [38] Focus group discussion is a qualitative technique that can provide insights into the attitudes and beliefs that underlie behavior and provide context and perspective that enable experiences to be understood in their entirety [39]. Participants can describe their experiences in more detail and can provide distinct insights into how they assign significance to and organize their thoughts [40]. Focus group discussions are particularly advantageous when interactions between research participants are likely to encourage a more informative outcome; this is especially the case when participants are within a similar context and are collaborative with each other [41]. The meeting with the students occurred on a day convenient for everyone outside of class time. Before and prior to the start of the meetings, they were informed that the meeting would be audio-recorded, that participation was voluntary, and that consent forms were available for those who wished to participate. The discussion centered on a number of key themes to arrive at a clear concept and expression of the impact of the use of VR on their learning experience. This included their views on the significance of adopting new ways of learning, the difficulties of adopting new ways of learning, and VR as a new tool of learning in architectural education. Notes were also taken during the discussion, enabling more effective summaries of the focus group after transcription.

5. Results

5.1. Quantitative Inquiry—VR Activities

Based on the analysis of the data from the three quantitative inquiry activities, incorporating VR as an aided educational tool has a noticeable impact on students' learning outcomes. As depicted in Figure 2, following the sequential participation in the three activities, VR students performed better when answering the follow-up questions compared to the non-VR students in terms of their knowledge gained through the use of VR technologies compared to conventional teaching methods. Analytical and critical thinking skills were found to be higher in the VR conditions.

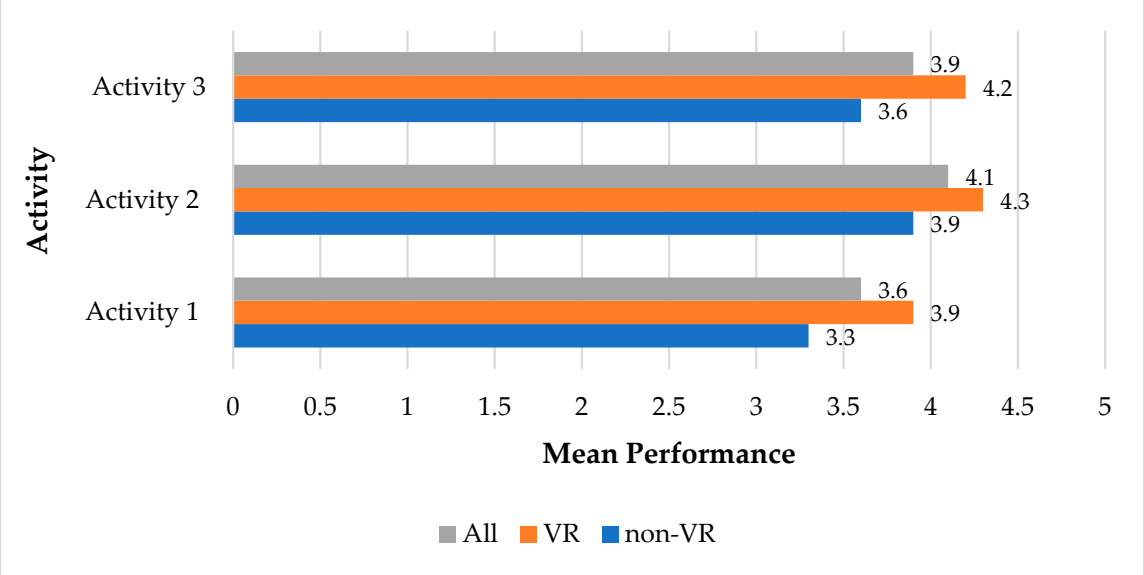


Figure 2. Descriptive statistics of correct responses means of students' use of VR technology and non-VR.

In order to address the research aim, the following primary question was explored in the quantitative evaluation: does the use of VR techniques in architectural learning/teaching increase students' ability to visualize and understand certain architectural features in comparison to 2D conventional teaching methods? This was achieved through a set of five binary-response questions in the post-evaluation questionnaire. Thus, in order to establish whether the use of VR technologies in the delivery of architectural teaching

materials results in a deeper and better learning experience, the mean performance of the post-evaluation study was computed for VR and non-VR for each activity as presented in Table 3. The *X*-axis shows the mean values (0–5), while the *Y*-axis shows the three activities. The means for the VR group (orange bar) and the non-VR group (blue bar) and the overall performance mean for each activity (grey bar) were computed and reported as shown. All three activities showed a higher understanding of the architectural location related to the particular activity in the VR group in comparison to the non-VR group. In addition, the overall mean of correct answers in each activity in both groups increased due to the partial use of VR in delivering the activity, which subsequently suggests the potential benefits of blended teaching methods in the delivery of architectural teaching materials. Activity 1 groups were shown (Hagia Sofia church); the mean of correct answers for the non-VR group was 3.3/5, while the VR group's mean of correct answers was 3.9/5, which shows considerably better performance in the VR group. Similarly, Activity 2 groups (Notre Dame Cathedral) showed a better understanding of the building in question when VR was used, with the VR group mean of correct answers being 4.3/5 in comparison to the non-VR group with a lower mean of correct answers of 3.9/5. Finally, Activity 3 participants were shown (Santa Maria del Fiore Cathedral); the VR group mean of correct answers was 4.2/5, while the non-VR group mean of correct answers was 3.6/5. These results highlight the significance of VR technologies in students' cognitive awareness of architectural contexts and the importance of implementing VR into architectural teaching.

Table 3. The means of VR and non-VR through the three activities during the semester.

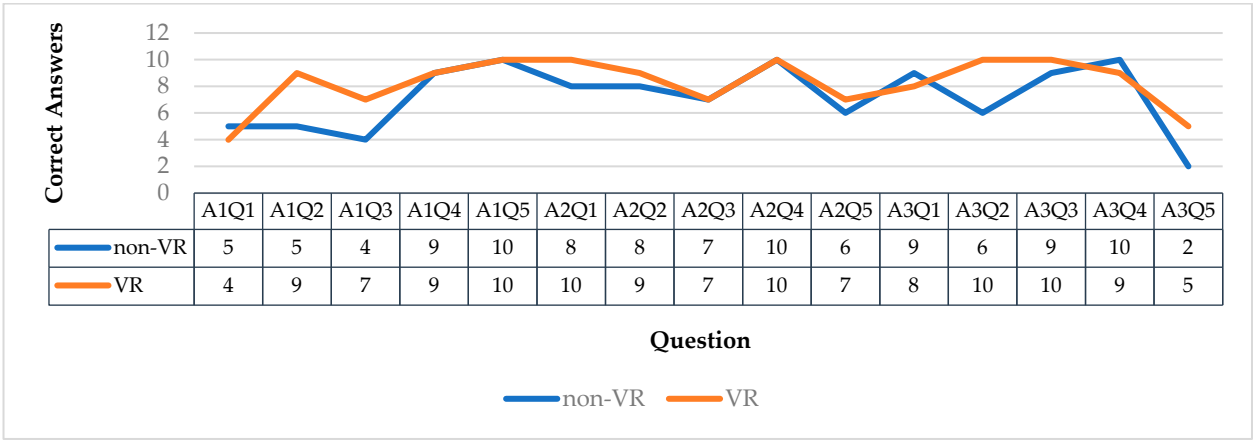
	Method	Mean	N	Std. Deviation	Std. Error of Mean	Grouped Median
Activity 1	non-VR	3.3	10	0.949	0.3	3.29
	VR	3.9	10	0.568	0.18	3.89
	Total	3.6	20	0.821	0.184	3.63
Activity 2	non-VR	3.9	10	0.738	0.233	3.88
	VR	4.3	10	0.675	0.213	4.33
	Total	4.1	20	0.718	0.161	4.13
Activity 3	non-VR	3.6	10	0.699	0.221	3.56
	VR	4.2	10	0.422	0.133	4.2
	Total	3.9	20	0.641	0.143	3.88

In relation to specific aspects of knowledge, it was observed that most of the variations related to questions A1Q2, A3Q2, and A3Q5. These questions were generally on the themes of architectural details, particularly interior details involving the use of color, type of lighting, and materials. On the other hand, performance did not significantly vary for questions A1Q4, A1Q5, A2Q3, and A2Q4. These questions were generally on the themes of layout and spatial orientation (see Figure 3). The figure illustrates the number of correct responses for each question for all three activities, where A1 refers to Activity 1, A2 refers to Activity 2, etc., and Q1 refers to Question 1 of the particular activity, and so on. The orange line represents the number of correct answers for each question for the VR groups, and the blue line represents the number of correct answers for each question for the non-VR groups.

5.2. Qualitative Inquiry—Focus Group Discussion

The focus group discussion took place at the end of the module, allowing students the opportunity to fully evaluate the impact of integrating VR elements into their course. The participants had been part of various activities, including VR and non-VR, thus giving them a holistic and well-balanced view. The discussions were organized in a congenial atmosphere to allow free expression of views. The participating students were initially

questioned about their subjective perceptions of using VR. The entire group (with no exceptions) expressed a general positive attitude towards its use as an educational tool. The reasons provided for this positive attitude include appreciation for the practicality of the tool, especially considering it as an alternative to actual field trips. For the majority of the participants, the level of realism was acceptable, especially in view of the logistical challenges associated with field trips and site visits following the onset of the COVID-19 pandemic. The unconventional nature of this approach aided students in developing a sense of enthusiasm and passion, thus making it an enjoyable experience when compared to traditional methods. Although they found the pedagogical impact to be similar in terms of comprehension of knowledge, their general view was that VR provided better satisfaction. Another advantage highlighted by participants was the ability to re-explore the case study sites at any point in time. This emphasizes the importance of revisiting these sites to discover their intricacies whenever students require verification of specific information pertaining to any given structure or site. All participants, with no exception, were willing to continue to use this approach for other modules that require careful examination of architectural spaces. The participants, however, identified a few limitations of VR although they did not believe this affected their experience. The general limitations of VR mentioned include the following: difficulties in navigation in the virtual environment; inability to touch or feel when compared to real site visits; and general technical difficulties in setting up. According to students, however, these challenges are only in relation to comparing VR use with real site visits. However, when compared to traditional teaching with slides and images, they found VR to be more satisfying.



	A1Q1	A1Q2	A1Q3	A1Q4	A1Q5	A2Q1	A2Q2	A2Q3	A2Q4	A2Q5	A3Q1	A3Q2	A3Q3	A3Q4	A3Q5
non-VR	5	5	4	9	10	8	8	7	10	6	9	6	9	10	2
VR	4	9	7	9	10	10	9	7	10	7	8	10	10	9	5

Figure 3. Performance per question of VR and non-VR.

6. Discussion

The findings from this study highlight the importance of new technologies for an enhanced learning experience in architecture and, in particular, for more effective blended learning [42–46]. This study further supports the assertion that VR is one of the newest and most promising technologies, which can create more student-friendly immersive learning environments [40]. The majority of this study has been based on blended learning delivery, as well as the usage of learning media that is based on VR technology. Many studies have recommended approaches for implementing blended learning and VR-based learning media in architecture education; however, none of these studies have explored the use of VR as a blended learning facilitator in the context of the History of Architecture or examined its impact on the acquisition of higher-level cognitive skills [47–51]. In addition, despite the fact that these previous studies provided essential insights into VR use in architecture education, none of them focused on the learners' views and levels of satisfaction, especially in the context of history in architecture.

This study has provided empirical evidence that incorporating VR technology in teaching the History of Architecture module provides a better learning experience and is

preferred by architecture students. VR motivated learners to discover and research more and offered numerous benefits as an effective, sustainable, and scalable learning method to the students. This is in line with previous studies [30,32].

This study's findings also support the importance and relevance of VR technology in situations where physical site visits are not possible. This is particularly relevant where visits to sites of architectural importance are abroad or international. Thus, VR bridges the gap to and logistical challenges of physical site visits by offering a near-realistic alternative. Studies have similarly outlined this as an important benefit of VR [33]. In addition, with HE shifting more and more towards blended learning and away from physical field trips, VR enables students to enrich their experience of relevant structures with the least economic impact and cost. This is particularly important given the fact that economic factors associated with field trips are known as a barrier to the learning experience from students' point of view, as suggested by [12]. Furthermore, this is a more sustainable alternative to site visits, offering a better experience than other traditional education alternatives.

The use of VR in teaching architecture enhances students' perception and acquisition of design and details by enabling students to visually and audibly experience architecture. First, the act of viewing historical architectural structures in VR has a significant role in expanding students' visual libraries, enhancing their immersion in real life, and improving analytical and critical skills; this supports other studies [20]. Second, experiencing historical buildings in VR provides a deeper understanding of past and current design practices by paying close attention to all the interior details, materials used, and architectural elements of each building presented during the semester. As similar research suggests, VR videos of international historical structures, for instance, promote comprehension to the greatest extent possible [33]. Finally, using VR as a learning tool in HE provides students with the opportunity to practice and get familiar with digital skills-related knowledge, which is increasingly becoming a key skill to acquire for a modern-day career in the fields of the built environment [12]. Evidently, students' familiarity with this type of technology and their ability to engage in this set of activities were major contributors to the smooth integration of VR into the module teaching methods.

VR tools also allow students remote access to learning resources where they have access to cheap VR devices. Such opportunities to learn outside of the classroom using VR can facilitate the acquisition of critical thinking skills. Despite the benefits of VR, however, there remain some challenges in integrating it into all aspects of the curriculum [14]. Even though evidence of high-level learning outcomes was observed across all three activities throughout the semester, it was limited in terms of the number of topics it could facilitate. It was easy to incorporate VR into these activities that related to visits to historical sites; however, it was not used for other general lectures that were delivered using only traditional methods [12]. Consequently, VR-enabled content in architectural theory courses must be rigorously pedagogically designed to support and implement learning across a larger number of activities. This study found that VR enables higher-level thinking skills (e.g., developing and employing analytical thinking to evaluate historical architectural concepts, materials, and methods).

7. Research Conclusions and Limitations

The purpose of this study was to determine the significance of incorporating VR technology as a sustainable learning aid in the delivery of the History of Architectural module. The aim was to expand students' horizons by utilizing VR as an immersive blended learning resource. The findings of the research highlight the impact of using VR technology as an aid in delivering architectural theoretical learning materials. This study found VR to increase students' learning experiences as well as their recollection of knowledge and overall satisfaction when compared to traditional methods. The findings further emphasize the role of digital technologies in enhancing students' learning experience. This research provides recommendations for adopting and incorporating new technologies in HE for a better learning environment in the following ways: (1) HE institutions must begin to

provide VR technologies and equipment as a standard resource in architectural theory education; (2) in addition to virtual visits of sites, the curriculum must be designed to enable VR use for demonstrating other concepts of design; and (3), finally, architecture students should be encouraged to use VR for their own self-learning as it provides the opportunity to revisit sites several times on their own and at no further cost.

This study was limited to the History of Architecture module; thus, despite the relevance of the findings to other related studies, the conclusions may not be applicable to all modules. However, it can also be interpreted as an indication of how a particular technology for education can provide students with a variety of learning experiences and how well it can achieve expected learning outcomes. Additional research could include a larger sample size focusing on the effects of participation in various learning/teaching approaches on academic performance, attitudes towards blended learning, and metacognitive awareness of students.

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References

1. Oliveira, G.; Grenha Teixeira, J.; Torres, A.; Morais, C. An exploratory study on the emergency remote education experience of higher education students and teachers during the COVID-19 pandemic. *Br. J. Educ. Technol.* **2021**, *52*, 1357–1376. [CrossRef] [PubMed]
2. Hockly, N. Blended learning. *Elt J.* **2018**, *72*, 97–101. [CrossRef]
3. Castro, R. Blended learning in higher education: Trends and capabilities. *Educ. Inf. Technol.* **2019**, *24*, 2523–2546. [CrossRef]
4. Al Maani, D.; Shanti, Z. Technology-Enhanced Learning in Light of Bloom's Taxonomy: A Student-Experience Study of the History of Architecture Course. *Sustainability* **2023**, *15*, 2624. [CrossRef]
5. Soergel, B.; Kriegler, E.; Weindl, I.; Rauner, S.; Dirnaichner, A.; Ruhe, C.; Popp, A. A sustainable development pathway for climate action within the UN 2030 Agenda. *Nat. Clim. Chang.* **2021**, *11*, 656–664. [CrossRef]
6. Michelsen, G.; Fischer, D. Sustainability and education 1. In *Sustainable Development Policy: A European Perspective*; Taylor and Francis: London, UK, 2017; pp. 135–158.
7. Sanchez-Santamaria, J.; Boroel-Cervantes, B.I.; Lopez-Garrido, F.M.; Hortigüela-Alcalá, D. Motivation and Evaluation in Education from the Sustainability Perspective: A Review of the Scientific Literature. *Sustainability* **2021**, *13*, 4047. [CrossRef]
8. Ronaghi, M.H. The effect of virtual reality technology and education on sustainable behavior: A comparative quasi-experimental study. *Interact. Technol. Smart Educ.* 2022, *ahead-of-print*. [CrossRef]
9. Wood, R.; Shirazi, S. A systematic review of audience response systems for teaching and learning in higher education: The student experience. *Comput. Educ.* **2020**, *153*, 103896. [CrossRef]
10. Zairul, M.; Azli, M.; Azlan, A. Defying tradition or maintaining the status quo? Moving towards a new hybrid architecture studio education to support blended learning post-COVID-19. *Archnet IJAR Int. J. Archit. Res.* **2023**, *17*, 554–573. [CrossRef]
11. Nicol, D.; Pilling, S. *Changing Architectural Education: Towards a New Professionalism*; Taylor & Francis: Abingdon, UK, 2005.
12. Ben Ghida, D. Augmented reality and virtual reality: A 360 immersion into Western history of architecture. *Int. J.* **2020**, *8*, 6051–6055.
13. Sołtysik, M.J. Developing students' spatial skills and teaching the history of architecture through structural drawing. *World Trans. Eng. Technol. Educ.* **2020**, *18*, 12–17.
14. Chan, C.S.; Bogdanovic, J.; Kalivarapu, V. Applying immersive virtual reality for remote teaching architectural history. *Educ. Inf. Technol.* **2022**, *27*, 4365–4397. [CrossRef]
15. Puggioni, M.; Frontoni, E.; Paolanti, M.; Pierdicca, R. Scoolar: An educational platform to improve students' learning through virtual reality. *IEEE Access* **2021**, *9*, 21059–21070. [CrossRef]

16. Haleem, A.; Javaid, M.; Qadri, M.A.; Suman, R. Understanding the role of digital technologies in education: A review. *Sustain. Oper. Comput.* **2022**, *3*, 275–285. [CrossRef]
17. Jones, C.; Shao, B. *The Net Generation and Digital Natives: Implications for Higher Education*; Higher Education Academy: York, UK, 2011.
18. Ellis, R.; Goodyear, P. *Students' Experiences of e-Learning in Higher Education: The Ecology of Sustainable Innovation*; Routledge: London, UK, 2013.
19. Buultjens, M.; Robinson, P. Enhancing aspects of the higher education student experience. *J. High. Educ. Policy Manag.* **2011**, *33*, 337–346. [CrossRef]
20. Guney, D. The importance of computer-aided courses in architectural education. *Procedia Soc. Behav. Sci.* **2015**, *176*, 757–765. [CrossRef]
21. Wang, T. Rethinking teaching with information and communication technologies (ICTs) in architectural education. *Teach. Teach. Educ.* **2009**, *25*, 1132–1140. [CrossRef]
22. Doyle, S.; Senske, N. Between design and digital: Bridging the gaps in architectural education. *Charrette* **2017**, *4*, 101–116.
23. Al-Ansi, A.M.; Fatmawati, I. Integration of ICT in higher education during COVID-19 pandemic: A case study. *Int. J. Learn. Chang.* **2023**, *15*, 430–442. [CrossRef]
24. Al-Ansi, A.M.; Jaboob, M.; Garad, A.; Al-Ansi, A. Analyzing augmented reality (AR) and virtual reality (VR) recent development in education. *Soc. Sci. Humanit. Open* **2023**, *8*, 100532. [CrossRef]
25. Jacobson, J. Ancient Architecture in Virtual Reality: Does Immersion Really Aid Learning? Doctoral Dissertation, University of Pittsburgh, Pittsburgh, PA, USA, 2008.
26. Sherman, W.R.; Craig, A.B. *Understanding Virtual Reality: Interface, Application, and Design*; Morgan Kaufmann: Burlington, MA, USA, 2018.
27. Wohlgenannt, I.; Simons, A.; Stieglitz, S. Virtual reality. *Bus. Inf. Syst. Eng.* **2020**, *62*, 455–461. [CrossRef]
28. Youngblut, C. *Educational Uses of Virtual Reality Technology*; Institute for Defense Analyses: Alexandria, VA, USA, 1998.
29. Fabris, C.P.; Rathner, J.A.; Fong, A.Y.; Sevigny, C.P. Virtual reality in higher education. *Int. J. Innov. Sci. Math. Educ.* **2019**, *27*, 69–80. [CrossRef]
30. Chen, F. Teaching research of integrating virtual reality technology into environmental design professional courses. *J. Phys. Conf. Ser.* **2021**, *1744*, 042220. [CrossRef]
31. Dave, D.; Shreya, P.; Baghel, A. Searching new pedagogy: Teaching history of architecture in architecture institutes. In *Scholarly Communication, Open-Access Publishing and Ethics, Proceedings of the International Conference, Vijayawada, India, 25–26 October 2018*; BS Publications: Hyderabad, India, 2018; pp. 25–26.
32. Ibrahim, A.; Al-Rababah, A.I.; Bani Baker, Q. Integrating virtual reality technology into architecture education: The case of architectural history courses. *Open House Int.* **2021**, *46*, 498–509. [CrossRef]
33. Latif Rauf, H.; Shareef, S.S.; Najim Othman, N. Innovation in architecture education: Collaborative learning method through virtual reality. *J. High. Educ. Theory Pract.* **2021**, *21*, 33–40.
34. Jason, L.; Glenwick, D. (Eds.) *Handbook of Methodological Approaches to Community-Based Research: Qualitative, Quantitative, and Mixed Methods*; Oxford University Press: Oxford, UK, 2016.
35. Daniel Nelu Travel Vlog 360° Videos VR4Holiday 2020, 360° VR Ayasofya Istanbul Hagia Sophia Virtual Tour Walk Travel Visit Turkey 5K 3D Virtual Reality. Available online: https://www.youtube.com/watch?v=8cbYbQKGwoE&t=4s (accessed on 25 March 2023).
36. Ching, F.D.; Jarzombek, M.M.; Prakash, V. *A Global History of Architecture*; John Wiley & Sons: Hoboken, NJ, USA, 2017.
37. Hamlin, A.D.F. *History of Architecture*; Biblo & Tannen Publishers: New York, NY, USA, 1897.
38. Robson, C.; McCartan, K. *Real World Research: A Resource for Users of Social Research Methods in Applied Settings*; Wiley: Hoboken, NJ, USA, 2016.
39. Creswell, J.W.; Clark, V.L.P. *Designing and Conducting Mixed Methods Research*; Sage Publications: Sauzende Oaks, CA, USA, 2017.
40. Carey, M.A.; Asbury, J.E. *Focus Group Research*; Routledge: London, UK, 2016; Volume 9.
41. Creswell, J.W.; Poth, C.N. *Qualitative Inquiry and Research Design: Choosing among Five Approaches*; Sage Publications: Sauzende Oaks, CA, USA, 2016.
42. Surry, D.W.; Land, S.M. Strategies for motivating higher education faculty to use technology. *Innov. Educ. Train. Int.* **2000**, *37*, 145–153. [CrossRef]
43. Sife, A.; Lwoga, E.; Sanga, C. New technologies for teaching and learning: Challenges for higher learning institutions in developing countries. *Int. J. Educ. Dev. Using ICT* **2007**, *3*, 57–67.
44. Perera-Rodríguez, V.H.; Moriña Díez, A. Technological challenges and students with disabilities in higher education. *Exceptionality* **2019**, *27*, 65–76. [CrossRef]
45. Wilen-Daugenti, T. *Edu: Technology and Learning Environments in Higher Education*; Peter Lang: Bristol, UK, 2009.
46. Alamri, H.A.; Watson, S.; Watson, W. Learning technology models that support personalization within blended learning environments in higher education. *TechTrends* **2021**, *65*, 62–78. [CrossRef]
47. Megahed, N.; Hassan, A. A blended learning strategy: Reimagining the post-Covid-19 architectural education. *Archnet-IJAR: Int. J. Archit. Res.* **2022**, *16*, 184–202. [CrossRef]

48. Asad, M.M.; Naz, A.; Churi, P.; Tahanzadeh, M.M. Virtual reality as pedagogical tool to enhance experiential learning: A systematic literature review. *Educ. Res. Int.* **2021**, *2021*, 1–17. [CrossRef]
49. Hutson, J.; Olsen, T. Virtual Reality and Art History: A Case Study of Digital Humanities and Immersive Learning Environments. *J. High. Educ. Theory Pract.* **2022**, *22*, 417.
50. Ip, H.H.; Li, C. Virtual reality-based learning environments: Recent developments and ongoing challenges. In *Hybrid Learning: Innovation in Educational Practices: Proceedings of the 8th International Conference, ICHL 2015, Wuhan, China, 27–29 July 2015*; Proceedings 8; Springer International: Berlin/Heidelberg, Germany, 2015; pp. 3–14.
51. Wang, P.; Wu, P.; Wang, J.; Chi, H.L.; Wang, X. A critical review of the use of virtual reality in construction engineering education and training. *Int. J. Environ. Res. Public Health* **2018**, *15*, 1204. [CrossRef] [PubMed]

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