

Augmented Reality and Virtual Reality: A 360° Immersion into Western History of Architecture

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ABSTRACT

The purpose of this study is to describe the importance of using new technology-based tools in the form of augmented reality (AR) and virtual reality (VR) as an adequate solution to help meet students' educational needs, and help in their professional development. Both tools, put together, play an important role in the History of Architecture teaching process, providing an entertaining and engaging way of acquiring information and building critical thinking skills. History curricula and all core architecture courses are prepared for students' performance attainment balancing between theoretical and professional training. However, students' performance, their learning and interest in the courses may be affected by the teaching method. This paper contributes by presenting different approaches for using AR and VR tools and concludes about the potential of their use in: 1) improving significantly the learning experience in the Western History course, and 2) positively changing the mental image the students previously had about the course.

Key words: Blended learning, didactic methods, immersive pedagogy, design education, architectural design, critical thinking.

1. INTRODUCTION

The main role of architecture education is to facilitate students learning, to help them acquire the best knowledge, the best technical skills, and the highest positive values and ethics deemed necessary in their future work. The educator's role is to improve students' qualifications, competencies and skills during their university years. In architecture, classes are divided into theoretical and practical, i.e., students have theoretical courses like the History of architecture, and practical courses like Design Studio.

Architectural history is a course that describes and analyses architecture, starting with ancient times and gradually progressing to contemporary times. Western history course enables students to improve their knowledge about contemporary, historical, and cultural contexts, and to refine their creativity using a variety of traditional and emerging technologies previously used in architectural projects.

Students will have to use their critical thinking to deconstruct and explore architectural projects in their details and thereafter get enough tools for inspiration. Combined with the studio program, the History course helps students in learning a wide range of materials, design processes, technologies and techniques that can be applied in their own architectural projects.



Figure 1: The classical PowerPoint presentation at the University of Texas[1]

Students have long studied History of architecture by understanding: 1) the principles that influences architecture, 2) architecture and art by close observation, and 3) develop an ability of critical thinking. All the information they learn is important and relevant, but in the current high-tech generation. A History class in the form of a long PowerPoint (PPT) full of slides and pictures is currently pictured by students as boring and unimportant in their training as architects (Fig. 1). Additionally, the course comes with its taboo; students always tell me that they had in mind. History class will be a memorization course following a traditional and boring approach.

In order to engage these students, AR and VR as high-tech tools come to the rescue. Both offer an innovative way to immerse architecture in an interactive experience with the course.

2. WESTERN HISTORY OF ARCHITECTURE COURSE: CURRENT STATE

Western History of Architecture (WHA) within the design curricula in architectural and interior design has long been a compulsory university degree to start from freshmen or sophomore. Hence, WHA is a compulsory course for all architecture students. The course main objectives are the knowledge acquisition of the fundamental lines and critical reading skills of historical architecture. The full-frontal lessons with the methodological teaching approach illustrate case studies with reading essay articles and aim to extrapolate emblematic events, related to architecture, cultural areas or individual protagonists in order to trace the main lines of the development of architectural phenomena.

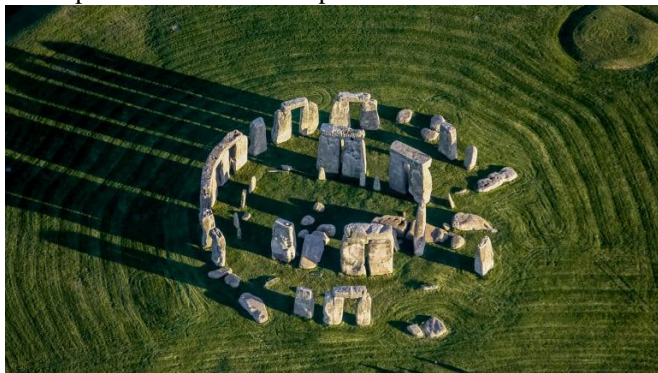


Figure 2: Stonehenge prehistoric monument c. 3000 BC [2]

By favoring a reading where the interaction between the project and its context stands out, material-constructive techniques, technological and linguistic aspects are also considered in relation to contemporary architecture. During the five years education path, the students will be able to develop and enhance their critical learning skills for a greater and conscious quality of architectural understanding; acquire notions and sedimentation of architecture and urban planning, and strengthen their ability in making explicit arguments, proposals and clarifications for their own architectural design studio projects.

The teaching tools consist mainly of projecting pictures to students inside a classroom of historical buildings, or historical sites (fig. 2). By showing these pictures through PPT slides, the students are supposed to understand the composition complexity of these architectural master pieces, i.e., Pantheon geometrical mass composition - solids and voids (fig. 3), or that are creating the positive and negative spaces that makes Rome (fig. 4). However, this teaching method has a weakness which is showing a 3D object or environment to the students in a 2D format- PPTs - We barely see the Pantheon dome from the ground. Using videos has also proved to be ineffective. WHA class continued to be negatively stereotyped and called a waste of time by these students.

After using this teaching tool in WHA in more than three universities for almost 10 years, I came to the conclusion that this method of presentation is not efficient. Sophomore

students cannot fully understand architecture while just seeing flat pictures – The Pantheon dome is hidden to the eyes; several pictures are necessary to show its volumes composition. In conclusion, the course teaching method had a demotivating effect on the students who obviously were more interested in their design studio and had no idea what History class can do to their formation.

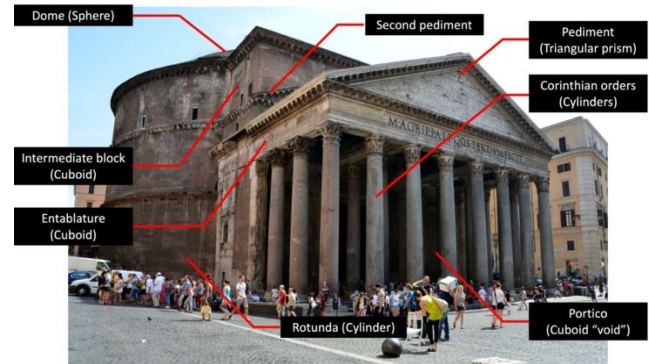


Figure 3: The Pantheon mass composition (Source: Author)

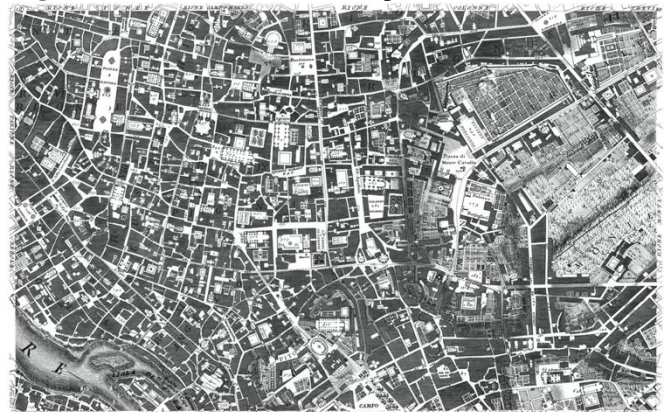


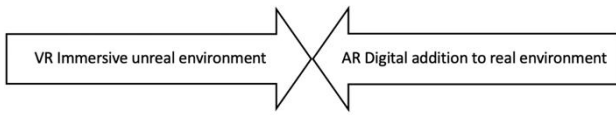
Figure 4: Positive and negative spaces in Rome - Rome Tile 5 of the Nolli Map of Rome 1748 by Giambattista Nolli[3]

3. WHAT IS THE DIFFERENCE BETWEEN VR AND AR?

In terms of instrumental-technical and experiential point of view there is a clear difference between VR and AR despite their great vicinity.

The VR is a computer-generated simulation of a three-dimensional synthetic or naturalistic environment, allowing the interactivity of the user by a headset (a visual head mounted display) and controllers equipped with motion sensors [4]. The headset reproduces a 360-degree virtual unreal scene accompanied with audio while the motion controllers transmit the tactile stimuli to the software to be transformed into virtual movements: immersive navigation through the 3D environment with hands controllers. This technology is used for example in education, video games, medicine or training military pilots and astronauts. It takes a lot of time to prepare but it gives an excellent immersive experience. The students are thus part of a simulation, the teacher would shut the real world and immerse them in the

world of the Roman empire so they can live it in person. It makes the students feel they are walking through the buildings or inside them (fig. 5).



On the other hand, AR is the expanded real physical environment with additional virtual computer generated/manipulated unreal motion tracked contents and/or animations [4]. For example, students can start with a real-life view through their smartphones or tablets camera to see a blended digital reconstruction with the real world on their device's screens (fig.6). Glasses used in AR are known as connected head-up displays.

The different applications of AR technology are: education, video games i.e. Pokémon Go, design, architecture, medicine, archeology, visual art, etc.

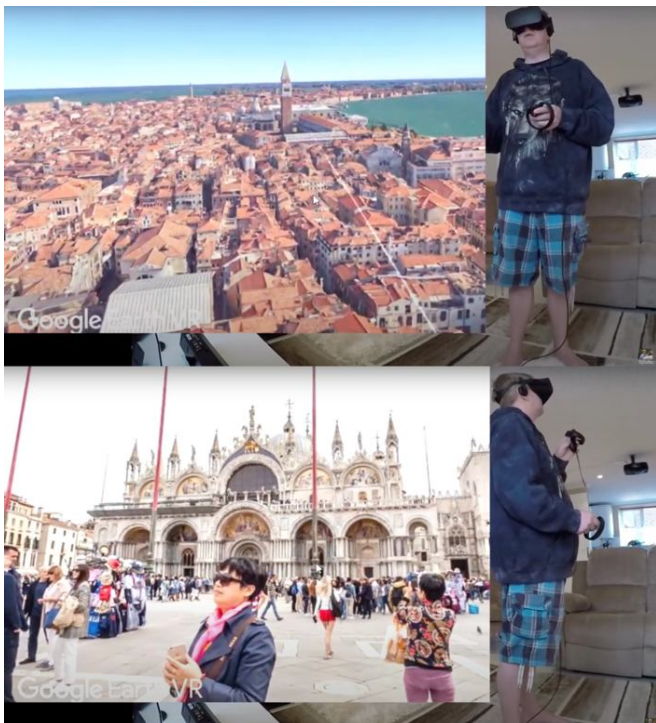


Figure 5: Screenshot, flying over Venice (Italy) and landing at Piazza San Marco using Google Earth VR[5]

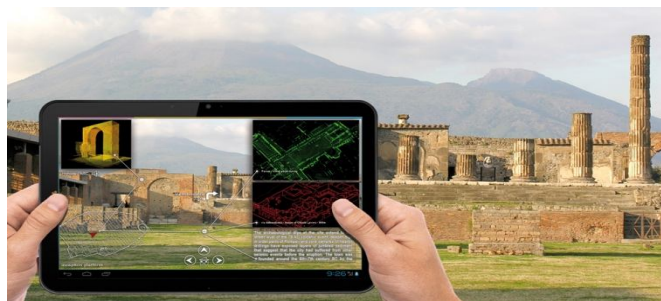


Figure 6: A visitor pointing at a cultural heritage site in Italy with a tablet to see more details through Inception AR platform [6]

4. HOW CAN VR AND AR CONTRIBUTE TO THE EDUCATION OF ARCHITECTURE STUDENTS?

Technology has been gradually but steadily making strides in revolutionizing teaching methods. As the next generation of media transformation is coming, AR and VR are becoming vital in education technology. Indeed, a 360-degree view of any architectural content gives a realistic feel to the students and helps them explore their courses with profound detail. A detailed visualization of the historical site is the best way for a deeper understanding of the subject and the development of awareness of the historical perspective. So, among the benefits of VR and AR is the full immersion in a historic moment where the students can analyze up close the architectural details, just like a city tour. It is also an opportunity for the students to save time and high travel costs to real-life tours abroad.

Often, architecture schools use field-trip as an educational tool, most of the time, students will travel to visit historical or contemporary buildings for human scale experience. At Vellore Institute of Technology, architecture students are requested to do a national and an international field trip during their curriculum at high costs and high risks (especially now during COVID-19 Pandemic), and going through a number of authorizations requests (table 1).

Table 1: Field-trip at Vellore Institute of Technology (Source: author)

	Description
Number of students	80
Number of Professors	4
Duration	2 Weeks
Costs	16.000 USD
Transport methods	Trains, buses and flights
Where	North-East India "Bhubaneswar, Varanasi etc."
Gained university credits	2
Frequency	One mandatory field trip for South or North India during the study curriculum for all students. However, about two field trips are organized each year in a radius of 150km as complementary teaching for design studio or theory classes.

As a sustainable and more secure alternative to field-trips, architecture schools could use the VR for human scale immersion of students into the desired educational tour. Not only the VR technology allow architecture students to see and experience in 360-degree the Coliseum in real scale, but also to experience it in AD320, fig. 4. It is not only a 3D experience, but it is a 3D environment where the use can walk through and interact. Students can even walk through Hadrian Villa and visit the Southern theater which is located in a private property-Not accessible to tourists (fig.7).



Figure 7: Screenshot from the actual in-app footage “Rome Reborn”[7]

Additionally, students in architecture can use VR and AR to visualize their construction plans, modify their 3D drawings, perform modeling, etc. Both applications allow them to improve their understanding of planning a document, interpreting an error, following a construction process, and experience different solutions related to design or construction.

A doctor can be guided through AR while performing a surgery by 3D contextual information superimposed on the operation table, an architect can save time and money while making an interactive visit of a building to a client. Similarly, the students can benefit from this innovative technology during manual or technical training, it would guide the apprentice in the different tasks to be performed. Architecture students can easily experience their own projects from form to function. AR and VR increases student’s interaction and involvement, providing them guidance through additional indicators and information, as a matter of fact, the architecture student will be an active actor in his learning experience.

However, this technology cannot be implemented alone; it must be combined with traditional teaching methods. Virtual learning environment integrates the traditional way of teaching by bringing the real world into the classroom [8]. This helps the immersion of architecture students into the course, improves their attention and concentration while eliminating all other distracting elements: Smartphones.

The following is a list of few universities who tested or implemented the VR or AR in their design/art related programs.

Instead of wasting time, attention, and energy on laptops, tablets, and smartphones, these same digital overloads may be used in VR educational purposes. This paper suggests to use VR and AR as tools in the WHA teaching process to make the lesson more interesting. Previous studies [17; 18) found that virtual reality is helpful in designing phase of structural system during design stage, and gives the perfect visualization of any physical changes. Moreover, during geography lessons-observations, it was reported that the students asked more complex questions that the usual, showed a higher rate of participation and a higher sense of analysis and evaluation during a VR lecture comparatively with a normal class [19].

More case studies are summarized in the table below (Table 2).

Unfortunately, there are not enough researches describing students’ knowledge verification process after their VR experiences.

Table 2: Some examples of universities who started experimenting VR/AR in their teaching (Source: author)

Who?	What?	Field	Reference
Utah State University	At the Utah State University, the department of Landscape Architecture and Environmental Planning used AR as an innovative experimental tool to teach landscape construction. It helped the 21 students enrolled in this course to identify several ways to improve their projects. The use of AR visualization with Microsoft HoloLens mapped their surrounding environment resulted of a better understanding of the design details and concepts using models in real physical location (Singh, 2018). Beside the success of this experiment, students reported difficulties to control the application through air-tap gesture and material colors differentiation	Landscape architecture	[9]
MIT	According to Kent Larson, director of Changing Places Group at MIT, the AR is helping them to model and simulate innovative urban contexts using Lego bricks. The outcome of this data visualization study has a direct impact on actual challenges i.e. wellness, global warming and pollution. They discovered how urban density i.e. parks proximity and mobility systems i.e. bike lines are correlated with people health issues like heart disease, diabetes or obesity	Urban planning	[10]
Queensland University of Technology	From transformative learning to mobile blended learning, AR offered new learning experience to students while engaging with theory.	Landscape architecture	[11]
Georgia State University	Using VR to visit inaccessible architectural historical sites using Google Cardboards. However, co-design the databases is essential to the success of any VR project.	Art history	[12]
University of South California	The department of architecture at University of South California, USC, are adopting a different strategy by offering a 17 weeks course to architecture students in Realtime computational representation: game engines and virtual reality. Walkthrough simulation, light, textures and crowd simulation are the skills to be mastered by the students through the spring semester. According to the course syllabus, this course will help students to re-consider traditional conceptions of space and representation with the help of a 1:1 scale simulation.	Architectural design	[13]
The Chinese University of Hong Kong	About 3000 students and 200 teachers from primary and secondary schools in Hong Kong are benefiting for the Chinese University of Hong Kong initiative in using Virtual Reality (VR) Technology to Enhance Students’ Understanding of Colonial Architecture in Hong Kong. The new student-centered teaching method replaced the mundane textbooks and the impractical field trips. The initiative was not only limited to VR historical sites but also to add narration and drama elements to the 3D visualizations for a better immersive and dynamic virtual experience. The audio feedback from students is stated to be more in-depth than the post-trip written feedback form. Beside the fact that all digital material produced is repeatedly used and shared with other schools	History of architecture	[14]
Mount Saint Mary College, NY	Used Google Cardboard glasses within Google Street view app to teach history of art and architecture. The main features of the teaching were: 1. tricking the brain which perceives motion 2. creating an illusion of depth: was achieved by projecting different images to each eye 3. the use of head-mounted displays for a full virtual immersion	History of architecture	[15]
Florida State University	Students from the Jean Hudson ‘s Information Technology in art history used VR googles from Google Cardboard to experiment a virtual leaning experience in art history.	Art history	[16]

In most cases, VR is used as a tool to help students learn and practice their lecture topic, but they usually take a written test to test their learning abilities. It would be interesting to have an application that reports students' progress with a gradual automatic evaluation until their final exam.

5. CONCLUSION

VR and AR offer innovative solutions to boost the interest of architecture students and increase the efficiency of their learning process. If the immersive and interactive experience proves effective, it may lead to the merge of History class to design studio which is promising. Students' performance can only get better. The main point is students' performance will get better if students do something rather than just sit in lectures, and that is what technology is changing.

VR and AR tools act on multiple levels on the learning process that can enrich the experience by a transmission in a digital world and do not aim to completely replace the teacher-student relationship. Teachers in higher education have a major challenge to take in order to design technological solutions that fit the learning problems of the new generation of students.

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