

# Educational Advancements in the Field of Augmented Reality and Virtual Reality

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**Abstract**— Technology has constantly kept on evolving since many years. This has helped in the growth of many fields throughout the world. One such important field is Education. Different technologies have helped education to grow positively and help everyone learn and practice with ease and understanding. Technology has proven to be a useful aid in education, as it enables teaching methods to be eased and efficiency enhanced by incorporating economical and effective means of transmitting digital content. Researchers have shown us that Virtual Reality and Augmented Reality have great potential to support two types of users: students, on the one hand, increase productivity and from the other teachers, broaden their teaching techniques. Hence, it makes the experience of education and learning more effective and stimulating. Nonetheless, even for non-skilled developers, there is no specifically designed platform for the flexible creation of AR/VR content. There is therefore a need to develop new tools to allow users to easily become producers of such experiences.

**Keywords**— *Virtual Reality, Augmented Reality, Education*

## I. INTRODUCTION

The rapid growth of VR along with AR has helped in many domains all around the world. Virtual Reality(VR) means that, rather than using the conventional human machine interface or screens, VR combines three-dimensional computer graphics technology, sensing technology, artificial intelligence technology, and so on, viewers fully immerse themselves in the three-dimensional environment generated by computers. Augmented Reality(AR) evolves on the basis of VR technology, by using computer graphics and display technology, it can incorporate and locate virtual objects or information, then position the virtual objects accurately into the actual world by using the sensing

technology which can successfully fuse the physical and virtual objects through some relevant equipment to obtain the information. Robotics and material engineering are some areas which consist of minute structures where VR can be implemented[1]. One of the recent example of the usage of this technology is the Facebook Horizon[2]. It is to be used with the help of a virtual reality headset which involves user interacting with various objects and places. The user can move in the space and explore new things. Safety has also been considered in this system as the user can access the safe zone if he/she feels unsafe and can even report the content if needed. This is one of the practical example of AR/VR that has been trending recently. In this COVID pandemic, augmented reality along with virtual reality has gained a lot of importance. There were already certain devices like the head mounted glasses and displays which were used prior, but these devices have also helped in fighting this disease. Several countries have used such devices in detecting the temperature of the opposite person approaching near you. The use of head mounted displays is also been practiced in various countries in which people can have a full-fledged AR occurrence[3]. Besides this, augmented reality is also helpful in various domains like healthcare, tourism, marketing and many more.

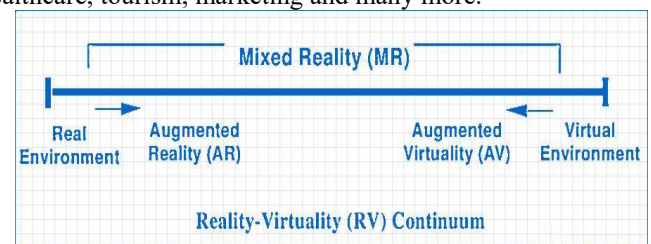


Figure. 1. A representation of a reality-virtuality (RV)

The virtual world and the actual world are two ends of the continuum as shown in Figure 1 given by Milgram et al. We consider a real-world setting, instead of a complex definition of existence in science, where it is restricted to laws of physics and objects in the real world can be clearly sensed as they actually exist. A virtual world, on the other hand, is a computer-based artificial environment that may or may not obey laws such as time or gravity and so on[4].

## II. AR-VR IN EDUCATION

AR and VR technologies are very helpful and favourable to education. It can help students to learn and build their skills with an efficient way. There are some students who might get bored by the usual learning practices and hence these technologies would attract them in learning and motivate them. The AR/VR technology would also help students to solve their doubts as they would have a practical view of the particular object. This would increase their interest in that field. This would help them avoid any assumptions and learn the subject the way it is. Virtual reality can provide instant contact and students can participate at the same time in a virtual classroom. We can communicate, get instant feedback from others and feel a sense of being in the same places as their classmates.

In general, the utilization of this technology has been targeted to entertainment purposes like visuals, animations however education too has been imparted with the help of it. There are many studies on the efficiency of the use of AR in education. The majority of research on the use of AR and VR in education is targeted at people with typical development and particularly at STEM education, introduction of any chemical elements with its atomic weight or learning the model of any planet in the class can be learnt. There are many other such applications in the field of education enlisted below.

### A. AR-VR in Medical Education

AR helps students to imagine structures that are difficult to interpret using dissection and increases the spatial perception of students as well. The majority of students found it beneficial in learning the anatomy and location of the ventricles and the vestibular system by AR simulation. It was hard to observe the ventricular and vestibular systems in humans by dissection. This should therefore, enhance students' spatial awareness and would help them to understand things more precisely. Another benefit of these AR simulations was that the students were able to use the simulation at any time and, as in a dissection room, were not limited in time. AR was chosen by most people as it was a helpful, attractive and inspiring tool for students. Furthermore, AR allows learners to collaborate with classmates in a group to learn the content. This can create an atmosphere of student-centered learning that allows all students to actively participate in anatomical education[5][6]. Likewise, in education, the structure of the heart is a complex structure that enables students to use a VR simulator to display cardiac anatomy to provide a 3D image. This helps in the ability of students to develop their spatial understanding and to construct a 3D mental picture. As a consequence, the group using the VR simulator achieved a higher test mark than the group using textbooks

in the Maresky et al. report. Neuroanatomy was another dynamic framework that students found difficult to research. Kockro et al. found that 3D VR simulation, rather than 2D, was favoured by undergraduate medical students. Visualization capabilities, like the 3D representation of anatomical objects, are major characteristics. Other sensory elements, such as touch feedback, may be introduced as well[7]. There has even been the discussion of providing a haptic device[8] for various medical applications related to any body part replacement as it requires a strong power that might be given by robots. This would be a great help for VR training.

### B. AR-VR in Geometry

Few research has been done in the domain of geometry to systematically develop virtual reality technologies for practical training purposes and to improve the spatial skills of learners. There is a three-dimensional geometric construction method called as 'Construct3D' which is used for the fields of geometry science, pedagogy, and augmented reality for mathematical and geometric education. This tool helps in creating a collaborative environment between teachers as well as the students. It also helps in developing a student's skills and optimizing the transmission of information effectively[9].

In addition to this, there is another tool named 'SketchUp' which uses augmented reality in viewing 3D models that can be posted within the same software directly to the web and stored straight away in the database.

Next, we have 'HandWaver' which is a gesture-based mathematical construction environment that allows use of virtual reality technology to allow users to create one, two or three-dimensional mathematical objects by repeating gestures. Its aim was to take advantage of the visualization phase available in virtual worlds to create experiences in which learners produce and modify math structures with their hands[10].

'VRMath' is an immersive educational VR/AR technology that helps students understand different aspects of mathematics, such as 3D geometry, vectors through the use of virtual and augmented reality technologies. It provides students the ability to move within a particular setting, manipulate objects, and construct object-building projects in a three-dimensional environment[11].

Lastly, another virtual educational environment, designed for immersive mathematical exploration, is 'CyberMath', which consists of four large exhibition halls, each with a series of mathematical constructions that convey a common theme. The students and the teachers are in different physical locations while using this virtual medium.

One of the VR example that is used is the MathworldVR. It is a system that consists of a VR headset to encourage users for an immersive experience. Majorly all such systems can be operated by the mobile application but this can be used through the device's browser[12]. It is a very helpful virtual reality simulator as it can scale functions, show graphs and other such math components in three dimension. This helps in understanding the subject math in a much deeper and an understandable way.

### C. AR-VR in special needs education

Compared to the reports of the use of AR in education, there are very less of them including education for special needs. This technology would actually work as a good solution for the people who are not able to learn due to their various diseases or disability. The obstacles faced by students with disabilities can be minimized by the benefits offered in recent years by the advancement of technologies.



Figure 2. AR-VR for special need students

The use of portable devices can help students to engage in different VR-AR applications which would enhance their learning. The problems that students usually face would be overcome by incorporating AR-VR technologies. With the upcoming advancement in technology, more research should be done in this field that would help any student with any disability to experience education to its maximum[13].

### D. Future use of AR-VR in education

AR-VR is an upcoming field and will surely be emerging with a lot of development. With the ongoing pandemic, it has been in more talks due to its features and use. There are various companies that have introduced AR-VR in the educational market. It will not only be useful to school going students but also to undergraduate college going students. Besides its attracting features and characteristics, it actually helps a person in one to one full engagement with proper interaction. We are not far from the time where there will be proper full fledged AR classrooms in every country.

## III. OTHER APPLICATIONS OF AR-VR

Besides education, there are many applications and uses of augmented reality and virtual reality in the field of Education. This AR/VR technology has gained a lot of importance in many other domains also. Our team has developed a demo which consists of a phone capturing a magazine. The magazine consists of various objects which upon being scanned give the three dimensional view of that particular object. We have used Unity along with Vuforia to develop the AR application that allows the user to scan and present its 3D view. Some of our captures have been shown below. Some of the other applications where this technology has been extensively used are specified below.

### A. Healthcare

Healthcare is a very important field to which augmented and virtual reality has been catered to. There have been various countries have developed tools that help the doctors to visualize the 2D model into the corresponding 3D model. This helps in better understanding and is also time effective. A 3D view of any surgical scan performed helps in a better practical view. This application would help the doctors to perform any operation or surgery more efficiently and would even save a lot of time. Surgeries are very important in the

medical and healthcare field. A surgeon must be able to distinguish as to which tissue is a healthy one and which one is actually damaged. Hence a surgical microscope[14] would be of great help that would enable the surgeon to identify various delicate parts easily with high resolution and proper imaging with the help of augmented reality.



Figure 3: AR-VR in healthcare

### B. Tourism

This is another application that has prospered since the past few years. Tourism always accounts to the economy of any country. This technology can act as our guide when we visit different places. People always want to know the historical importance of that particular place be it a museum, monument or a palace. With the help of this technology, one can actually scan the monument and get details of it just within a second. Furthermore, on scanning it can even replace that particular object with its 3D object. Imagine looking at the 3D view of the object from different angles rather than the 2D statue. The first application that was specifically built for tourism was Tuscany+[15] helping the tourist with an enhancing immersive experience.



Figure 4 AR-VR for tourism

### C. E-commerce

As we know that online shopping has been increased to a very large extent since the past few years, be it for clothing or furniture. A person can actually check on the clothes on him/her before buying it. Moreover, it is also helpful in buying furniture as one can simply place that furniture in the living room just to check how it looks. The person need not step out of his/her house for such shopping. This had definitely gained importance ever since the COVID pandemic, where people can shop online and get a perfect feel of the things that they wish to buy. Figure 5 shows an augmented chair along with a normal chair besides, emphasizing how it can be easier for a customer to understand and buy it. This was developed by our team and



was scanned in such a way that it can be compared with the real chair as shown in the image below.



Figure 5. AR-VR for E-commerce

#### D. Marketing

This has been the most famous application in use nowadays. It consists of magazines, brochures, billboards and many more. Business Cards form a huge means of marketing. Many companies have invested in this feature for their brand promotion. This very feature attracts the user due to which the user is more adamant in knowing and engaging with that company. All that the user need to do is scan the business card, by which he/she will get all the information in an augmented and an attracted way. Figure 6 shows a 3D image of a t-shirt which we got on scanning an advertisement page in a magazine. This demo was developed by our team for exploring augmented reality. Initially, multiple target images were taken and stored in the database provided by Vuforia. Each image is stored is considered as a target image which upon scanning by the AR camera would provide this three-dimensional view as shown in figure 6.



Figure 6. AR-VR for Marketing

#### IV. CONCLUSION

This paper primarily focuses on explaining as to how AR-VR can be useful in the field of education. Initially, it explains augmented and virtual reality. In addition to this, it also explains the other applications of AR-VR as to when and how is it used and can be used.

Augmented Reality and Virtual Reality have gained a lot of attention from the past decade. Although, there are many

applications and benefits of this technology, there is a lot of research that is needed to be done in this field with respect to safety, security and other such aspects. With growing technology, we see more and more applications of AR-VR not only in education but also in other fields.

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