Smart Vision of School Classroom

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Abstract. Modern technology has become an integral part of our daily lives. Every day generates the need for new technologies so that we can coexist and integrate into contemporary life. Virtual reality (VR) is becoming imperative in some life areas, such as medicine, space, and education, for experiments and training. The start of the COVID-19 pandemic revealed the importance of using electronic devices for content delivery. In this paper, the importance of VR in the COVID-19 crises, the current situation of virtual reality, and its applications in the fields of education are discussed. Therefore, state of the art for VR is explained in this study with the new scientific contribution in this field and the new vision of VR in education. Virtual reality has advantages and disadvantages, and both current and future ones are discussed here. Based on our current data, we found that there are tremendous positive developments taking place, but at the same time, there are rules, laws, and societies with certain policies, some of which will promote the environment of virtual reality, and others will oppose it.

Keywords: Virtual reality · COVID-19 pandemic · Smart schools

1 Introduction

The recent rapid progress in research affects all aspects of technology [1–5], and for this reason, this age is sometimes called the "technology or digital age". The technologies that are mostly affected is virtual reality (VR). New applications have been introduced to use VR headsets in video games to enjoy reality for entertainment purposes. Recently, researches are conducted to investigate how VR can be applied in education and training. This topic receives massive interest from researchers, who have significant and positive results for the education process concerning engagement, performance, and emotion. Nowadays, smart hubs have appeared everywhere, and many countries are trying to build smart cities.

Moreover, the general simulation framework that has been adopted in the teaching process is based on Kunter and Trautwein's model [6]. This model identified the dimension of instructional quality, classroom management, constructive support, and cognitive activation. Because there is so much focus on smart cities, the next fifty years will witness

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huge changes, especially in the education field. Distance learning is already reforming schools, but in 2050, it is expected that all schools will be replaced with smart schools or virtual schools. VR innovation is loved because of its potential to increase engagement between teachers and learners, enhance learning outcomes through immersive learning, and bridge the gap of educational equity by ensuring that learners get experiences they would have missed using traditional technologies.

1.1 Significance and Novelty of the Study

Mainly Over the past few years, a growing body of knowledge has covered how virtual reality can improve the learning outcomes. An investment in virtual reality for education targets more than the need to improve learning outcomes. The recent challenges with the COVID-19 pandemic reveal that schools and all institutions of learning must innovate increasingly so that they continue dispensing knowledge, especially for medical institutions that now use VR for the training of nurses and doctors [7]. The pandemic has revealed to the world the key importance of moving beyond canvas and blackboard in online learning, especially where the lessons are supposed to be immersive. Therefore, the focus of the study is at a time when the education sector has observed the renewed importance of technologies in teaching and learning. Introducing VR in education is an excellent way of promoting effective teaching and learning technologies at schools. This study is aimed at supporting practitioners in the education field to gain insights into the current technologies that exist, its advantages and disadvantages, and how they can embed it in the education field, especially in the current situation the whole world is experiencing; COVID-19 pandemic. This situation forces all schools worldwide to move to online. Online teaching is not easy and has many disadvantages and challenges that makes it beyond reality. To overcome these issues, this research encourages schools to adopt VR technology during online learning. VR technology will be an aid to achieve the principle of teaching with high quality. To the best of our knowledge, there is no research conducted that focuses on the advantages, disadvantages, drawbacks of using VR in education. So, we hope that the findings of applying VR in education and classroom would guide and add value to the educational technology research community.

1.2 Research Framework

This paper highlights state of the art in VR. It focuses on VR technology from two perspectives: hardware and software. Also, it summarizes how VR is embedded in education. Furthermore, the future vision, effect of using VR, challenges and other aspects are discussed in discussion section.

2 Literature Review

2.1 VR History

Artificial reality is a term that first emerged in the field of VR. Krueger [8] imagines a world created by a computer in which objects can simulate the real world by sensors that

track a participant's body that is displayed as a graphic image on the computer screen. The VR environment inspired another term that appeared before the emergence of the term VR. That is the term cyberspace, which William Gibson mentioned in his novels Burning Chrome and Neuromancer in 1982 and 1984, respectively. Cyberspace is a virtual space in the mind of a participant in which geographical boundaries disappear and in which all the transactions that generally take place in the real world, such as banking transactions, finance, telephone calls, and the processes of teaching and learning, are performed, to bring people together in an interactive way [8]. Sutherland [9] may have been the first to introduce the concept of a VR world in all its dimensions. Many tools and techniques existed that supported sensory stimulation. Still, only after Jaron Lanier came up with the term VR in 1989, the scientific community, the developers of VR technology, and the algorithms used were adequately brought together. Many researchers then began investigating the subject. In 2012, a Kickstarter project was launched named Oculus Rift, which consisted of an affordable, high-quality head-mounted display (HMD). Since then, technologies that support both good displays and sensory operations keep emerging [9].

2.2 VR Definition

In the 19th century, the roots of VR appeared in the form of panoramic murals. At that time, 360-degree art appeared. VR is defined in the Oxford Dictionary as "computer-generated simulation of a three-dimensional image or environment that can be interacted with in a seemingly real or physical way by a person using special electronic equipment, such as a helmet with a screen inside or gloves fitted with sensors.". In 1989, Lanier coined the concept of VR as an optical illusion that gives a sense of presence in a three-dimensional environment that exists only in a computer [9]. VR has many properties, of which immersion, interaction, and imagination are regarded as the most significant ones. VR as an environment is a type of 3D reality that uses a series of sensors that sense the utilities of ancillary facilities, such as glasses and sensor gloves, through which a set of inputs are converted to obtain 3D visualization, hearing, touch, and other perceptual levels [9]. VR as an interaction space: People interact in the 3D environment using motion-sensitive controls and move their arms, hands, and bodies in that virtual space, which provides a sense of reality to a completely different reality [10]. Immersion in VR: Full immersion allows users to immerse themselves in the environment and break away from reality using head-mounted display (HMD) technologies [10].

2.3 Immersion in VR

In VR, two main kinds of environments can be identified. The first kind is non-immersive, which is based on a computer that can simulate places. The second kind is immersive, which needs devices to perceive being physically involved in an imagined and non-real world. This involvement in the non-real world decreases the awareness of time consumed in the non-real world and even in the real world. All of this occurs because the user will be surrounded by images and sounds to absorb the same feeling of being in that unreal environment [11]. After immersion in VR had been developed, a model was created to illustrate how immersive VR software affects software architecture as shown

in Fig. 1. This model helps to engineer new software systems. In addition, it might help to understand existing software development systems and improve their work to be compatible with VR software development [12]. The lack of tools to help software engineers who build VR systems might be the main reason for the slow development in VR technology.

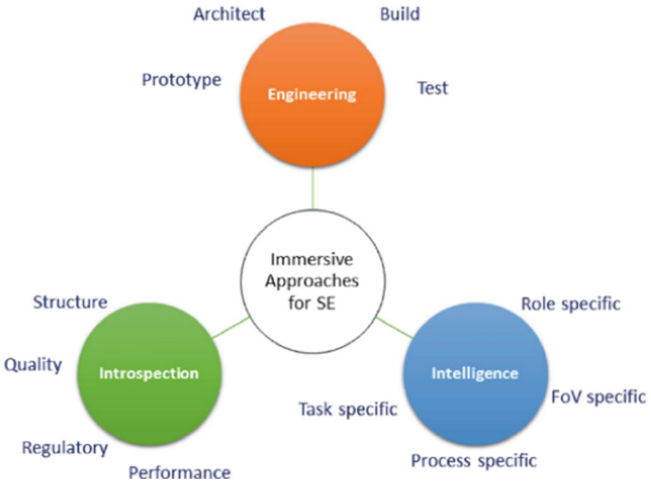

Fig. 1. Immersive approaches for software engineering affected by virtual reality.

2.4 VR Systems

VR systems are divided into two parts, as shown in Fig. 2. Two important factors were adopted in this division. The first is the quality of the techniques used in the manufacturing and construction of the system. The second factor is the level of mental immersion in the VR of these systems. Basic VR systems rely on the use of hand and screen, such as the use of mobile phones, to provide a vivid experience of VR, with digital cameras installed on smartphones providing the ability to identify areas and features that can give more accurate data to see the virtual world [13]. Enhanced systems with high mental immersion are also divided into partial mental immersion systems and total mental immersion systems [14].

2.5 Hardware Development

The development of VR devices depends on the manufacturing of devices that reflect human senses in VR, and companies compete in the development of devices and special tracking to include vision, smell, touch, hearing, and in the future, maybe also taste [15].

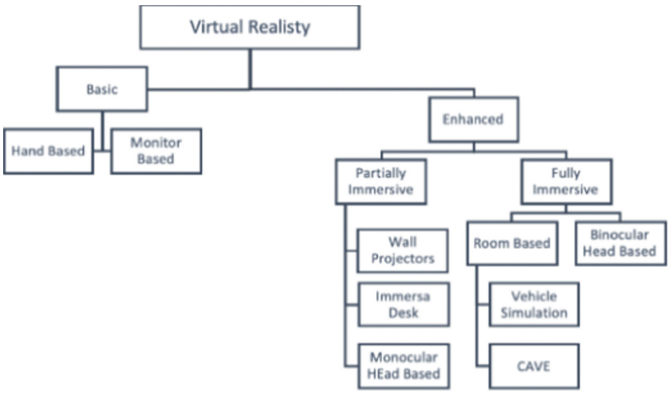

Fig. 2. Level of immersion in VR.

2.6 Software Development

There are many open platforms for the development of VR software, but VR in games such as PlayStation focuses only on entertainment and do not share open interfaces with everyone. Other companies have also designed their software development package [15] and have published many initial and open source projects on the GitHub platform. YouTube and Facebook currently allow 3D movies to be viewed in 360 degrees, with the HMD installed on the head, sensing the head's movement and affecting the camera's direction during the movie [15].

Although there are many software development methodologies, they cannot be applied to the manufacturing of VR software. The reason for this is that VR is a multidisciplinary area, including audio and video technology specialists, artificial intelligence technology specialists, art and graphic designers specialists, and senses and other human factors specialists; therefore, the current software development methodologies cannot provide multidisciplinary application design requirements [16]. VR software requires a software engineer to develop specific applications and a scenario designer, a fashion designer of objects in a virtual environment, a designer of a virtual environment according to requirements, etc. [17]. So, it might be difficult to have a comprehensive specialist for all those disciplines. Perhaps this specialty becomes available in the future.

3 VR Tools

3.1 Cave

A cave automatic virtual environment (CAVE) is a common example of a virtual environment macro-immersion system. It was created in 1992 by a group of researchers of the University of Illinois in a challenge to design a one-to-many visualization tool that utilizes large projection screens on the side walls, the floor,and recently on the surface [18]. In CAVE, users will use 3D glasses to feel that they are floating freely. The disadvantage of the CAVE technology is the high price because it does not only use the glasses but also need a special room equipped properly for this purpose. Also, there are the difficulties of changing place.

3.2 HMD

Head-mounted displays (HMDs) have been used as VR glasses in parallel with headphones to support immersive VR. Using those will give the user a visceral feeling of being in a virtual environment. However, immersive VR needs to include all the five senses to have a complete experience, but a maximum of two senses, namely sight, and hearing, are being used nowadays because they are the most important senses, as claimed by [8]. HMDs have not spread widely because of some drawbacks, such as high costs, mismatching between head movement and the scene shifting, and the perception of being in a virtual environment is not optimal.

3.3 Oculus Rift

Oculus Rift is another tool that resolves the previous tools' disadvantages in terms of cost and transportability. This tool enables VR systems to spread widely in education and training. This tool's weakness is that it cannot be used by children under 13, as indicated by "health and safety warnings," because the coordination and the balance between the senses are still under development at this age.

4 VR Applications

VR technology can be applied in different areas, such as education and training, aviation, medicine, military, space, engineering, robotics, entertainment, and healthcare. CAVE is one of the VR-based systems used by the U.S. Army to train the Mandarin language. Practice needs to put soldiers in a real situation and teach them to use their knowledge without putting them in danger, especially in the training phase [8]. In the military field, another study stated that military students who used a traditional way of learning, mainly lectures-based learning on, in this case, corrosion prevention and control, their learning skills are improved by 11%. On the other hand, an improvement of 26% was found for students who used immersive VR technology [19]. In medical fields, VR systems have been used in diverse applications aimed at nurses, patients, and doctors. It facilitates opportunities to train nurses in a virtual hospital to develop their skills through professional training. Also, applying this technology can be very useful for dental students because it enables them to exercise before starting with real people. Moreover, VR technology provides a significant opportunity for doctors to practice applying surgeries, virtually using HMDs and finger tracking. Thus, using VR technology in medical fields has many applications that could enrich beginning doctors with prior experience and ease the communication between the staff. The patient, too, has been targeted by VR, with many applications used for rehabilitation and therapy. Children with mild autism have been educated using CAVE. Also, VR has been used for disabled people to train them to handle food using HMDs [8].

5 VR in Education

The use of VR in education has expanded over the years. According to Bower, DeWitt, and Lai [20], the interest corresponds with increased affordability, accessibility, and

function of VR gadgets. The benefits of VR to education include enhanced immersion, improved spatial capabilities, promotion of empathy, increased motivation, and possible improvement of learning outcomes. The implications are that VR technologies have been observed as having massive potential for application in education and will be an essential component of teaching and learning for future schools.

Many things are difficult to experience in the real world, such as scientific experiments, a tour to the Moon, exploring the solar system, moving around the planets, moving to different historical periods of time and place [8], etc. But in the world of VR, all these things are certainly possible. VR in education has a wide application area because of its three basic immersion features, interaction, and visualization. Virtualization is increasing dramatically in education, especially in science.

Due to the maturity and evolution of VR technology, real interaction and actual immersion and the ability to visualize a three-dimensional world as a real-world have much-helped science students in creativity, innovation, and cognitive inspiration. Numerous studies have shown that people can remember only 20% to 30% of what they have seen, but 90% can be remembered through personal experience and simulation. Here, the virtual learning environment can improve the teaching process, create an unprecedented level of interaction, and design an effective and fully immersive learning environment to raise the level of student performance and improve the effectiveness of the skills and knowledge they have [9].

6 Importance of VR in Teaching and Learning

For learning to be effective, the classroom environment needs to be lively. [21] note that VR technologies are a potentially transformative tool in learning and teaching. The statement captures the observed potential of imparting education by applying VR in classrooms. Coupled with positive teachers' perceptions of VR, the platform's immersive potential and the offer to provide students with experiences they might otherwise not have with traditional learning tools are the two most important indicators of how VR would be used for classroom teaching. Current VR technologies allow students to visualize some of the mathematics concepts, such as spatial geometry, calculus, space, and different coordinate systems. In biology, the student can see the cells and reproduction process and closely observe biological life, including viruses, organs, and any other subjects related to living organisms [9]. In physics, students may be even more fortunate as they can experience the laws they have long heard about and see how they happen in front of their own eyes realistically, as well as further understand the concepts of energy, force, motion, and the physics of electricity and mechanics, which remain difficult to understand for many students. A primary school in China experimented using VR in teaching. The instruments used to integrate VR in the classes are shown in Fig. 3. The control system was operated using an iPad. Whiteboard and audio and VR glasses were used as well. The education resources were stored in the cloud.

Many theories on learning styles suggest different learning methods, and learners can choose the way that suits them. A well-known model has been presented by Devon and others [22], who stated that auditory, visual, and kinesthetic learning are three learning styles. Using any VR application in education targets and encompasses these three

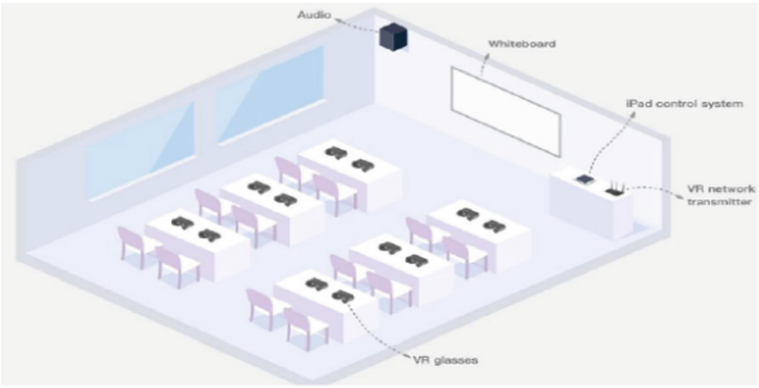

Fig. 3. VR technology in a classroom

learning styles; so, it might be useful for all learners regardless of their suitable learning style [22]. To illustrate these three learning styles in VR, a VR headset can render audio and visual signals and track movement. Gaytan and McEwen stated that for more added value in teaching and for more benefits for students' learning [23], the methods of learning should have variety. Thus, designing activities in VR technology is very flexible and allows the use of different methods in learning. Many scholars are interested in and focus on the benefits and effects on learners of integrating VR into education. Furthermore, there is a huge interest in finding out how e-learning can benefit from applying learning theories [24]. There are many advantages of using VR in learning processes. Current VR environments in education allow for a shared space for many learners. VR provides a visual space that contains many objects, graphics, lighting, and simulations of reality. It also encourages collaboration by communicating with many individuals and institutions worldwide that have the same interest in different fields [18].

7 Advantages of Using VR

Using VR in education has various advantages. Improved learning outcomes through immersion is the greatest advantage observed with technology [20]. A significant advantage is to emulate a situation that cannot be accessed physically because of safety, health, physical and ethical reasons. Ethical reasons include junior doctors who must practice surgery [11]. Health reasons like the Covid-19 pandemic that let most of the schools worldwide to stop teaching at the campus. Applying VR technology has several effects on students.

Performance effect: Many researchers have applied VR technology and noticed that the performance of students increased more compared with students that were taught in the traditional way. Hence, VR enhanced knowledge acquisition and understanding. Also, it improves recalling memories and remembering the material [11]. But in another study [25], the researcher stated that using VR might not affect transferring knowledge, and it might not different from using the traditional teaching. Emotion effect: The positive emotions increased compared with the negative ones when VR technology was

used in teaching. Conversely, in traditional education, the negative effects increased. Engagement effect: According to Zhang [25], VR had a positive effect not only on the interaction and engagement but also on interest and attention.

8 Disadvantages of Using VR

VR technologies raise the concerns of the invasion of privacy, confidentiality, and eavesdropping [26] with increased skepticism on technologies, it is paramount to prove that the anticipated disadvantages need to be solved. One of the major disadvantages of current VR applications is the motion sickness problem, with the object standing and the environment revolving around it. This problem often occurs in gaming applications [17]. Continued use of VR technologies in education will lead to serious health problems. *Cybersickness*: This is a condition of bad eyesight, headache, dizziness, and sometimes nausea or motion sickness during and after exposure to the virtual environment. This is due to the virtual environment's total immersion and to special devices used for a virtual experience environment [27]. *Virtual Addiction*: Addiction is generally defined as a psychological, behavioral state that affects a person and makes him or she want to do something to achieve psychological comfort. It has many causes, including psychological, social, and cultural causes. Whether for education or for play, the excessive use of the virtual world is addictive [28]. Addiction to VR leads to bone disease and visual impairment and severe mental illnesses such as depression and attention deficit, concentration, and anxiety disorders. Autism, introversion, and isolation are conditions that have increased considerably since the first days of immersion VR. Obesity and sleeping for hours can cause damage to brain cells.

9 Discussion

After reviewing the current situation of VR and its uses in education, we presented a futuristic view of what VR will look like in the future. Also, the impact of all these changes on society and other areas needs to be addressed. In addition to that, a number of challenges and proposals can be summarized in the following sections.

9.1 Future Vision

The new vision of VR in education and classroom is that the technology will become the mainstream educational channel, whereby all institutions of learning will be teaching using VR. Some of the current existing technologies include Google Cardboard. In 2050 smart schools, the classes will be entirely virtual, with the classroom space being a virtual space. Students can see where they are in the classroom and talk to their classmates or touch their hands through the students' input devices. The teacher here is a virtual teacher with a virtual body chosen by each student as appropriate. There is a virtual garden where students of the virtual world can enter and tour the facilities and thus enjoy playing in it or, for example, spending their break in it. One of the most influential things that will impact students in the virtual museum, where students can walk around and choose how long they want to see objects or events.

The student will record his digital fingerprint on each question, whether by fingerprint, face, or eye, and there will be cameras conveying images to the test organizers of the student working on the test. Today, the biggest obstacle to the use of VR technologies is the large-sized devices placed on the head or within reach of the VR experience, as well as the high cost. In the future, the cost will be reduced because of the high demand from all parties to use these technologies, especially in education.. Therefore, the devices will be light in size and may come in the form of a slide attached to the hand instead of gloves to give the feeling of things. Also, instead of devices that will be placed on the head, which can be considered large-size glasses, there will be just lenses worn, such as existing medical or cosmetic lenses, so that the person will be completed immersed in the virtual environment world.

9.2 Effect on Society

Many social communication skills will disappear and become communication through VR only, which will increase the incidence of autism and negative behaviors such as lying, theft, aggression, and fraud. In real life, committing crimes is prevented by-laws and rules, but in VR, those rules and laws will disappear, which will certainly affect students when they return to the current reality. Therefore, the current society must be made aware of what will happen in the future due to VR technology.

9.3 Cultural Effects

The virtual world offers the opportunity to integrate and indulge with all civilizations, cultures, and religions. It puts people in front of the whole world, giving them all sorts of ideas, which decreases the role of social and educational institutions and eliminates the customs and traditions recognized in all countries, possibly leading to several behavioral and ethical problems.

9.4 Workforce Effects

Some roles will disappear or decrease in smart schools, such as teachers, supervisors, coordinators, and secretarial jobs. But new roles will appear, and further qualifications will be required for teachers to be accepted in smart schools [17].

9.5 Challenges Faced by VR

There may be a lack of experts for developing VR content and building materials [11]. Not all subject areas are suitable for VR [22]. For example, learning to play a musical instrument needs tactile feedback. On the other hand, VR in education is costly and laborious, so applying it needs further investigation [22]. Teachers, students, and organizations may have difficulties practicing and using VR technology, so most of the difficulties researches revealed were technical difficulties [29]. Pediatricians will have more addiction cases with their patients, so they need to become familiar with the literature about the risk of using this new technology and its effect on health [30]. Privacy and

ethical issues will pose significant challenges. Students' behavior, location, and daily life routine will be recorded all the time, so these massive amounts of data could be analyzed and used for unethical uses. Real-time tracking of each move of a student can be vulnerable, and the developer must give high priority in the design to protecting students and preserving their privacy [30].

9.6 Suggestions to Enhance Integrating VR into Education

All the variables that will be influenced by using VR in teachings, such as motivation, transfer of knowledge, and students' and teachers' perceptions, should be analyzed [11]. The academic institution needs to accept this technology and prioritize, integrating VR into education [29]. Organizations should provide professional and proper training targeting all the aspects of education, managers, teachers, and students. Awareness sessions should be given for parents to inform them about the positive and negative effects of using VR, so they can keep an eye on their kids. New policies, called VR policies, are needed to cover all the aspects of using VR at school. User-friendly VR applications must be developed because [29]. So there is a need for applications that can be easily downloaded and used by anyone without prior experience.

10 Conclusion and Future Work

Efforts in upgrading VR technologies are continuing, and devices are evolving to create a more immersive experience in the world of VR as most organizations tend to apply VR technologies in their services to facilitate the user and provide a live experience. However, gaming companies are still the dominant developers of VR software and hardware. In the field of education, VR technologies are being tested in many educational institutions. Although there is progress, in this paper, the current reality of VR technologies in education has been reviewed. We have found that evolution continues unabated, experiments are being applied, and studies on the subject are deepening. There is a great interest in applying VR technologies in education because it raises students' level of performance and improves their capabilities and expertise through effectively simulating reality. Overall, the findings reveal the essential applications of VR in education. The growing interest in this area is proof that the technology will be critical to the future of schools and education in general. Since today's students are digital natives, implementing the use of more technologies in education is imperative. COVID-19 pandemic has shown how technology can be used to revolutionize the education sector. In future research, the focus may be better on virtual reality applications in education with real-world experiences than on I/O tools. Instruction.

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