Survey On AR And VR Technologies In Education

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ABSTRACT :

Technology has been advancing quickly and has a noticeable impact on many facets of life, including education. The uses of augmented and virtual reality (AR/VR) technologies in the architecture, engineering, and construction (AEC) business are gaining traction quickly thanks to updated equipment and developing technology. More researchers are beginning to use AR and VR technologies, particularly in education and training, to give students and trainees access to an immersive, interactive, and visual environment. Technologies such as augmented reality (AR) and virtual reality (VR), which provide immersive digital experiences, interactive environments, simulation, and engagement, have completely changed how we approach learning. However, in order to meet the huge demand in education, these technologies—which are still in the emerging stage—need to be heavily customized and heavily invested in. This study investigates the educational benefits of augmented reality (AR) and virtual reality (VR) for elementary, high school, and other students. Through an analysis of previous research works comparing AR and VR to traditional learning methods, the paper explores the positive and negative impacts of AR and VR on student learning. It also delves into the factors that influence the effectiveness of AR and VR in education

Keywords: augmented reality (AR), virtual reality (VR), Education, Comparative studies

Introduction:

With the increasing processing power of devices and the pervasive digital revolution, augmented and virtual reality technologies have reached a completely new level of development, enabling them to be applied to a wide range of new areas of human activity outside of the entertainment sector. These days, virtual and augmented reality technologies are a source of technological capabilities that help to expand already existing markets as well as to create new ones. [1] . Beyond its potential to improve gaming and entertainment experiences, augmented reality and virtual reality remain mostly unknown. A generation of tech-savvy kids, college-aged people, and professionals has emerged since the initial wave of interest in the 1990s, with the same curiosity and fascination as two decades earlier.

Each new technological age always ushers forth significant changes. An increasing number of people from diverse backgrounds are utilizing technology in the fourth industrial revolution [2]. Technology affects almost every facet of education. Growing technology developments have opened up new opportunities for the education sector [3]. With all technology, we as teachers and students now have unlimited opportunities to take learning beyond the limited classroom and can now access the whole world, in just a few seconds with the right access and devices [4].

In this paper, we delve into the realm of educational media, ranging from traditional books to interactive digital platforms, with a specific focus on the emerging medium of augmented reality (AR) and virtual reality (VR). While there has been significant research exploring the potential of AR and VR to enhance student learning, there is still a gap in understanding its full educational impact.

The plethora of research studies investigating AR and VR's potential presents a valuable resource for educators and technology designers seeking to enrich young minds through innovative technologies. However, despite this wealth of research, there remains a lack of comprehensive insight into the educational implications of AR and VR.

This paper aims to address this gap by synthesizing existing literature to provide a nuanced understanding of how AR and VR differs from other educational mediums. By analyzing academic publications that compare learning outcomes between AR, VR and non-AR or non-VR experiences, we identify both positive and negative effects that AR and VR can have on learners.

Moreover, we highlight various technological and psychological factors that may contribute to these observed effects. By examining these underlying factors, we aim to construct a model that elucidates how AR can be maximized for educational purposes.

AR can be made for learning media that cannot be done directly, for example, by observing an object in three dimensions. Only by using a cell phone or laptop can we observe something without having to do it directly. Then for VR itself, students can do things that are prohibited during this pandemic. For instance, when learning sports that are prohibited, we can watch how our teacher practices moves digitally by utilizing virtual reality (VR), which links all of our movement tools with a virtual. This allows us to mimic the teacher's movements and allows the teacher to evaluate our movements.

Technology known as virtual reality allows objects to be displayed as though they were in the actual world [5]. Both private individuals and large organizations have developed a wide range of technological advancements for a variety of fields. In fact, technology, which permeates practically every area of modern life, is incredibly easy to use and great [4].

A number of recent technology developments that should be considered while creating educational media include: Artificial Intelligence (AI) comes first. Artificial Intelligence (AI) is a technological concept that aims to mimic human intelligence and perform activities that humans can perform, such

making decisions, identifying patterns, or recognizing images [6]. Identifying students' learning preferences can be one of the ways artificial intelligence (AI) is employed in these learning materials to help it find the right learning resources and instructional strategies for each individual learner [7]. The Internet of Things (IoT) is the second. IoT is essentially a technological idea that allows all of the tangible things we use on a daily basis to be connected to the internet so that they may be readily and quickly accessed from anywhere at any time. One application of IoT in education is e-learning, which can function as a virtual classroom and even allow students to remotely meet in person with instructors or tutors via cameras-connected gadgets. Third, augmented reality (AR) and virtual reality (VR).

Through virtual reality technology, individuals can engage with a computer-simulated environment. Virtual reality (VR) allows users to immerse themselves in a condition that appears realistic and unfolds before them. While augmented reality (AR) is a technology that integrates virtual or two- or three-dimensional items into the physical world. Users can project virtual items as if they were real thanks to augmented reality technology. Innovations in technology, like these three forms of technology, will have an immediate effect on every aspect of life, including education.

The researchers are curious to learn more about AR and VR, including its applications, advantages, and drawbacks, based on the explanation provided above. Thus, this study's goal is to examine how augmented reality (AR) and virtual reality (VR) are used in education, particularly throughout the teaching and learning process.

Methodology

We must first define virtual reality and augmented reality, as well as the range of educational systems covered in this study, before we can discuss VR and AR in educational systems. Although there are differences in the precise definitions of virtual reality and augmented reality, most of them refer to (at least) a digital representation of a three-dimensional item and/or environment. We have also adopted this broad definition to cover VR and AR systems using any type of input/output peripheral in an effort to collect as many pertinent papers as feasible.

We also provide a number of recently developed AR and VR technologies in this study, comparing their features and functionalities to those found in our analysis. Due to the quick pace of development and improvement in specifications in this field, we concentrated our analysis on current studies for comparison's sake.

Literature Review

Augmented Reality (AR)

The realization of a virtual environment by the addition of virtual data to the actual, physical world is known as augmented reality, or AR. AR expands virtual information to the actual world as well as to streaming movies and games, and it offers a more straightforward appearance [8]. With the use of computer-generated 3D virtual objects, augmented reality (AR) technology allows users to interact with real-world things through the screens of their mobile devices [9]. Augmented reality refers to the process of "adding" computer-generated content to the real world—which can be viewed in person or through a device like a camera that produces real-world visuals [10]. However, Ismayani (2020) [11] notes that augmented reality is a technology that incorporates real-time, 2D or 3D computer-generated items into the surrounding actual world.

Technology known as augmented reality (AR) blends virtual and real-world elements to create 3D objects that can be seen on a screen. There are many applications for augmented reality in many industries, including education. Education is utilized as learning media in the augmented reality space to make it more engaging. A smartphone-style device or a reasonably well-specified gadget is needed for an augmented reality learning program. The elements of augmented reality itself comprise three-dimensional animations and pictures as well as an integrated camera inside the AR application.

3.2 Virtual Reality (VR)

A human-computer idea that simulates the future is called virtual reality, or VR. Via the internet, people can virtually travel the world. Virtual reality (VR) is a manufactured application created by many devices in real-world settings [8]. According to Musril et al [12] Virtual reality (VR) is a technology that allows people to enter and interact with a virtual world. It is a computer-based technology that combines specific input and output devices to allow users to interact thoroughly and directly with the virtual environment as if they were in the real world. Students can use computer assembly learning materials based on virtual reality at any time and for enjoyment, allowing them to learn without being restricted by time or place.

A human sensory experience can be replicated or mimicked in virtual reality. The majority of virtual reality systems use vision to create a virtual environment [13]. Through the integration of additional senses like sight and sound, virtual reality apps enable users to experience reality in a customized manner. Features of virtual reality include the ability to combine and detach experiences and interactions with the real world, making the virtual and real worlds identical. To present lifelike images, sounds, and other sensations that mimic the user's physical presence in a virtual environment, mainstream VR systems usually use a VR headset or multi projection environment. This indicates that using virtual reality equipment will produce high immersion, which is an immersive experience that immerses the user in a virtual world and makes them feel as though they are a part of it [14].

4. Technology in Education Medium

In the world of education, the ways we deliver learning materials have grown tremendously. Traditionally, students learned mainly from their teachers and classmates, along with resources like textbooks and videos. But as technology has advanced over the past fifty years, education has changed dramatically.

Digital media has become a big part of education now. This means students have access to all kinds of new ways to learn. They can try out interactive simulations and educational games, which not only make learning more interesting but also suit different styles of learning. At first, these digital learning tools were mostly found in classrooms with computers and smart whiteboards. But now, things have changed. With smartphones and tablets being so common, students can learn from anywhere, not just in the classroom.

What's more, how students interact with what they're learning has changed too. In the past, it was mainly typing and clicking with keyboards and mice. But now, there's something called augmented reality (AR) and virtual reality (VR) that's shaking things up. With AR and VR, students can interact with digital content as if it's part of the real world around them. They can move around and use gestures to engage with what they're learning, making it much more immersive and fun.

This shift isn't just about making learning more enjoyable; it's also about helping students learn better. By blending digital content with the real world, AR and VR creates exciting opportunities for hands-on learning and encourages students to think creatively and critically. As technology continues to evolve, augmented reality and virtual reality is leading the charge, opening up new possibilities for interactive and immersive learning experiences.

Finding and discussion

This study examines the advantages and disadvantages of using augmented reality (AR) and virtual reality (VR) in the education, with a focus on the teaching and learning process.

Benefits and Limitations of Augmented Reality (AR) and Virtual Reality (VR)

Learning becomes more engaging and hands-on with AR and VR. Students' memory recall increases as a result. For students that struggle with learning, it is really beneficial. It is anticipated that AR and VR will be one way to combat student learning boredom [15]. For easier comprehension, complicated subjects and concepts are analyzed and made simpler in both AR and VR. Students' freedom and autonomous learning are further encouraged by AR and VR. It is an excellent teaching aid that instils confidence in students. Instructors can incorporate interactive multimedia into their lessons, or they can use augmented and virtual reality technologies to boost interactivity [16]. The manner in which that digital gadgets and the actual world interact is expanded by AR and VR. With the ability to present text, photos, videos, music, and 3D objects to students in real time, media learning that makes use of this technology can substantially increase student knowledge [17].

It is possible to boost interest and learning passion with both AR and VR. If augmented reality and virtual reality are used in the classroom, students' attention is not just focused on visual books or other audio-visual resources when absorbing information. The three-dimensional impact that AR and VR create, which allows students to see real objects, helps them comprehend the topics being taught and piques their desire to think critically. In order to improve their learning, pupils might explore, examine, and gather experiences. The delivery of material by teachers is facilitated by both AR and VR. Learning activities are more enjoyable when augmented reality and virtual reality are used. Thanks to virtual reality technology, educators no longer have to cover a lot of material during lectures. The utilization of AR and VR in education has the potential to enhance the calibre of education in the long run.

A) Augmented Reality (AR)

The following are some of the earlier studies on the use of augmented reality (AR) in the process of teaching and learning:

Table 1 - Previous Research about Augmented Reality (AR).

Sr. No	Research Article	Result of Study
1.	*(Yapici & Karakoyun, 2021)* [18]	Biology professors were overwhelmingly excited about Augmented Reality (AR) activities. **Subject concretization, retention, excitement and enjoyment, the chance to repeat, and multimedia support were a few advantages of the AR activities.** Along with these benefits, a few drawbacks were mentioned as well, such as the inability to use for all topics, the requirement to keep a reliable phone, the passing of pupils over time, the cost, and the inability to connect to the internet.
2.	*(Kurniawan & Kusuma, 2021)* [19]	Students' interest in learning and their level of comprehension of the prayer content **can both be raised by utilizing the** AR application to teach Salat or Sholat. **This can be seen by an increase in scores both before and after using the program.**
3.	*(Restika et al., 2021)* [20]	Learning the components of the Total Station tool can be done more engagingly and interactively with the use of augmented reality. Users can access this augmented reality application anywhere, at any time, with just a smartphone.

| 4. | *(Ningrum et al., 2022)* [21] | Students' enthusiasm in studying can be raised with augmented reality (AR), electronic comic books, and integrated circulatory systems. Fifth-grade elementary school kids' interest in learning can be piqued by using augmented reality integrated electronic comic media to practice learning about the human circulatory system. |
| 5. | *(Wedyan et al., 2022)* **[22]** | **AR improves academic achievement and language proficiency**. **It also helps pupils become less anxious, more creative, and more involved in the group**. Furthermore, the pupils felt positively about using augmented reality to learn English. |

The following are some of the earlier studies on the use of augmented reality (AR) in the process of teaching and learning:

The information above indicates that there are more advantages than disadvantages to utilizing augmented reality (AR) technology in educational settings. With the emphasis on noteworthy aspects, augmented reality (AR) has great potential to bring history to life through multimedia material on mobile devices. By bringing the virtual world into the real world and turning everyday objects into 3D objects, augmented reality (AR) encourages pupils to study more and prevents repetition of lessons.

Because AR technology offers so many benefits, it's starting to replace traditional media in a number of industries.These benefits include: 1) Increasing the user's perception. Users in AR are given a more comprehensive view by 2D and 3D things. The user will be able to look deeper into the thing, not just its exterior. He perceives things differently as a result of this, considering them from different angles. 2) The experience of the user. In addition to looking, the user permits interaction when examining an object. The acquired experience will seem more genuine and intimate. It goes beyond merely being a theory that requires extensive development without an obvious application. 3) Adaptable to different devices. The user's tools might take many different forms, depending on what best suits their need. From the most basic gadgets to those that are sophisticated and expensive. These benefits make it clear that the major goal of utilizing augmented reality (AR) in education is to give additional understanding by elucidating more fascinating and in-depth subjects. Likewise AR technology does not monitor the user's perspective, which requires the application to be aware of the user's location beforehand.

B) *Virtual Reality (VR)*

The following prior studies have been conducted about the application of virtual reality (VR) in the process of teaching and learning:

Table 2 - Previous Research about Virtual Reality (VR).

Sr. No	Research Article	Result of Study
1.	*(Taufiqurrohman & Sumbawati, 2020)* [23]	The experimental class's average learning result value is 85.54 while employing the Project Based Learning methodology with virtual tours (virtual reality) as learning resources. Thus, **tour guide simulation learning can greatly benefit from the usage of virtual tour media.**
2.	*(Pavlova et al., 2020)* [24]	Sample assignments for ecological students are created using content from Google Expeditions, StreetView, and Youtube 360. **It is possible to study specific language for problems with climate change, ecosystems, energy, forests, oceans, seas, and water by using virtual reality technologies**. The authors contend that when students learn language, "virtual immersion" in real-world environments will **help them to acquire terminology related to specific careers.**
3.	*(Almira et al., 2021)* [25]	Test findings for virtual reality-based learning materials show an average percentage index of 86% and fall into the "Very Good" category, indicating that **these materials can successfully replace written learning materials that students find engaging**. The availability of virtual reality-based learning resources has made it possible for instructors and students to use these resources in the classroom, **particularly for subjects like fundamental photography**.
4.	*(Ahmad et al., 2022)* [26]	**With three-dimensional (3D) virtual modeling with a smartphone, the anatomical contour of the human body can be visualized with Augmented Reality technology.** On an Android or smartphone, augmented reality apps for cupping places on the human anatomy have been developed.

5.	*(Ariatama et al., 2021)* **[27]**	Through encouraging new approaches to learning media, **virtual reality (VR) raises student engagement, fosters critical thinking, and draws them closer to VR technology**. Virtual reality (VR) technology has the potential to **enhance the teaching and learning experience during a pandemic by drawing students in and creating an environment similar to a classroom during offline learning sessions**.

The information above demonstrates that there are more advantages than disadvantages to utilizing virtual reality (VR) technology in the process of teaching and learning. One possible application for a VR simulation would be to teach emergency procedures and spot possible problems [28]. An average learning outcome is obtained when using virtual tours (virtual reality) and the project-based learning approach. Virtual tour media is perfect for use in the learning process of tour guide simulation [23]. When studying vocabulary, students will be able to understand career-specific terminology through a "virtual immersion" in real-world settings [24].

In addition, virtual reality technology offers additional benefits like: 1) Enables us to view breathtaking landscapes from all over the world in a realistic and up-close manner. This is possible because virtual reality technology has extremely realistic visuals [29]. 2) We move a lot as a result. The data for playing games with this technology is different from that of games that we often play with just our fingers because we will be using many actions, such as jogging, walking, or simply moving our hands [30].

Virtual reality technology contains drawbacks in addition to benefits. These include: 1) Higher manufacturing costs are expected to occur. 2) Extremely constrained in production and use. 3) May lead to a rise in unemployment, which would mean fewer people would be needed to design projects. In addition, health concerns, the high cost of VR tools, and poor internet infrastructure are among the drawbacks of VR [31] [32].

1.1. Applications of augmented reality (AR) and virtual reality (VR)

1. Medical Education:

Virtual reality is widely used in medical education for training in various types of surgery, such as laparoscopy [1], temporal bone surgery [2], and dental procedures [3]. These VR tools often provide tactile feedback, allowing students to feel what they are doing. They offer a safe and cost-effective way for students to practice their skills without needing human or animal cadavers. Additionally, VR helps medical students visualize anatomy in 3D, giving them a better understanding of the body's structure than traditional textbooks [35].

Augmented reality is also used in medical training to help visualize anatomy, lung function, and laparoscopy. For instance, the "Mirracle" system uses a camera to create a mirror-like view of the user, but overlays images from a CT scan to show the user their own anatomy. It determines where to place the images using an infrared depth sensor from a Microsoft Kinect. Another example is ProMIS, an augmented reality laparoscopy simulator that uses a surgery dummy. It overlays labels and images of internal organs on the camera feed to help train and assess students.

2. Science:

Early uses of virtual reality in science education were aimed at visualizing chemical reactions (Bell and Fogler, 1998) and learning about molecules by assembling them in a virtual space[36]. More recently, augmented reality has been used to visualize processes like respiration and human meiosis with marker-based technology[37]. There's also an astronomy application that uses a head-mounted display to let students explore the solar system and understand its scale [38]. Virtual and augmented reality help students grasp abstract concepts and experiences that are hard to relate to real-world situations, such as a marker-based augmented reality tool for teaching electromagnetism and circuit interactions [39].

3. Engineering :

Various augmented reality apps have been developed and tested in introductory electrical engineering courses. One app, ElectARManual, displays animations and instructions over electrical machines in the lab, helping students learn to use them safely. Another, ELECT3D, is a markerless system that reads and interprets electrical diagrams. There's also ElectAR_notes, a study assistant that recognizes markers on course notes and enhances them with videos, animations, and more detailed information. Additionally, a virtual reality application was developed to teach micro-controllers and Arduino boards using Google Cardboard [40].

At a university in Brazil, a complete charcoal mini-blast furnace with all its subsystems was modeled in virtual reality. This application included additional information, videos, and 360-degree photos from real blast furnaces. It was used to teach engineering students how the process works and how the various subsystems interact [41].

4. Foreign Languages :

In foreign language education, virtual reality has been used to let students interact with native speakers through 3D virtual worlds using Desktop VR. One popular tool is Second Life, which is free, allows voice and text interaction, and lets users create their own content [42]. This helps bridge the distance gap, enabling students to practice speaking with native speakers from anywhere in the world [39][43].

5. Distance Learning :

The Internet has made distance learning more accessible and content-rich, but often the only ways for students to discuss and interact with classmates are through online message boards or email. Virtual reality can enhance distance learning by making class discussions easier and more natural. For example, lectures can be given in a virtual classroom like Second Life [44]. In this virtual space, students can ask questions if they don't understand something, the teacher can use discussion techniques to encourage critical thinking, and students can interact with their classmates before and after class.

Distance learning is especially challenging for classes that require hands-on lab work, such as science, engineering, or technology courses. One solution is to create a 3D virtual lab where students can perform activities. While virtual labs can't entirely replace hands-on experience, they can be used to teach basic skills, reducing the time and frequency needed in a physical lab [45].

5. Conclusion

There are no need to doubt the ever-improving technology of today. Virtual reality (VR) and augmented reality (AR) are two instances of technologies that offer users in the educational sector a novel experience. Both of these methods have their own advantages and disadvantages. To fully comprehend the effects of augmented reality (AR) and virtual reality (VR) on education, it is crucial to make this distinction beforehand. Augmented Reality (AR) is the addition of visual components, audio cues, or text to the already existent world. Conversely, virtual reality (VR) builds a brand-new simulation environment that gives students an immersive, dynamic, and interesting approach to learn about a particular subject. One option for educators and learners as a learning tool is this technology. Due to challenges in the field, this research has not been evaluated on research subjects and has instead led to recommendations for more study.

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