

## ADVANCEMENT THROUGH TECHNOLOGY – ROLE OF VIRTUAL REALITY (VR) AND AUGMENTED REALITY (AR) IN EDUCATION INDUSTRY

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### Abstract

Through a systematic review of the literature, this study explains how educational institutions can use technological advancements like augmented reality and virtual reality to catalyse global transformation and sustainable development. Additionally, the text outlines how AR and VR technologies facilitate interaction between educators and students. For younger pupils or those pursuing higher education, the integration of technology into the classroom may greatly enhance the educational experience. However, in many areas, the conventional methods of instruction—which place less emphasis on creativity and practical knowledge—have not yet altered. It is crucial to provide children, who represent the nation's future, with improved and higher-quality education.

Technological innovations such as augmented reality (AR) and virtual reality (VR) have the potential to enhance the interactive and immersive aspects of educational experiences, thereby maintaining student interest and enthusiasm. With AR/VR applications, teaching can be done in the classroom more effectively by visualizing concepts. For instance, medical students can practise surgery or work with visual objects that appear in the same space in actual and are pertinent to their field of learning. Virtual reality-based recreations provide a secure and regulated setting where students may hone their skills, critical thinking, and decision-making abilities.

**Keywords:** Technology, Virtual Reality, Augmented Reality, Education Industry, Digitalization.

**JEL Code:**I20, O33.

## 1. INTRODUCTION

Over a decade, world have seen tremendous technological progress that has revolutionised education and training, having a profound effect on modern society. Augmented reality (AR), first inspired by virtual reality (VR), is a technique that creates a mixed reality by incorporating virtual objects and pictures over the real environment generated by computers (Jiao et al., 2013). Alternative way to describe AR as a point along a spectrum of interfaces that connect the physical and digital realms., or as a "Reality–Virtuality Continuum." Fazel and Izadi (2018) described AR is a boundary among the cybernetic and physical worlds that enhances our perception of the real world by superimposing ever-increasing simulated data over real-world objects and scenes (Azuma, 2015; Fuge et al., 2012; Yang et al., 2013). Thanks to computers and the Internet, instructors and students may now work, study, and acquire information in previously unthinkable ways. This is one area where the amalgamation of AR and VR in teaching has notably altered the field (Mehrotra O. 2024). The significance of VR and AR technologies produces a newfangled virtual environment. The educational experience might

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undergo a complete transformation thanks to the promise of emerging virtual reality and augmented reality (VR/AR) technology. Virtual reality (VR) and augmented reality (AR), two distinct technological categories, leading the entertainment sector initially, the most. Nevertheless, such machineries are also being used in tutoring to assist children in learning new skills or ways of looking at the world. Virtual reality (VR) refers to a computer-generated environment that replicates aspects of the real world, allowing users to explore and engage with it through stereoscopic 3D displays and various additional devices (Stuchlíková et al., 2017). Individuals can engage with a virtual environment rather than the physical world by utilizing head-mounted displays and various virtual reality devices (Su et al., 2021; Wang & Zhang, 2021). On the other hand, augmented reality (AR) refers to the superimposition of digital information on a user's perspective of the actual world via the use of speciality lenses, glasses, or contact lenses, as well as apps that overlay real-time video feeds from mobile devices with virtual pictures. This is done to make it seem like experiencing more of the real biosphere or world (Shanu et al., 2022; Jeřábek et al., 2014). Because technology may play a crucial role in 21st-century education, technology-enhanced learning is growing in popularity (Alexander, B. et al., 2019). It may successfully address new educational demands, support teachers, enhance the quality of education, and enhance conventional education (López-Belmonte, J. 2022). Because VR/AR offers an immersive experience, its introduction into education has the potential to completely transform teaching and learning (Gandolfi et al., 2018). Before introducing technology to their kids, instructors should, nonetheless, methodically assess the technology's acceptability besides potential in the classroom (Faqih&Jaradat, 2021). One of the main benefits of AR and VR in education is their capability to produce dynamic and engaging experiences that may mimic actual occurrences.

Through practical, hands-on learning, this supports school communities in learning more successfully than they would with traditional methods.

The educational market for augmented and virtual reality (AR/VR) is experiencing substantial growth, driven by the increasing integration of immersive technology within classroom settings. Moreover, the main market drivers for VR/AR in education are the increasing adoption rates of virtual learning environments, advancements in VR headset technological trends, and a plethora of new commercial and educational partnerships. Virtual reality has completely changed the way that education is taught and learnt, providing students with engaging, interactive experiences that improve their comprehension of difficult concepts. Virtual reality has confirmed itself to be a powerful tool for attracting and diversifying knowledge through immersive and interactive learning. This is because virtual reality offers learners a minimally expensive and infrastructure-required digitally-crafted solution and context that mirrors real-world experiences that are otherwise unattainable.

## **2.REVIEW OF LITERATURE**

Researchers tried to investigate the role of mixing VR and AR knowledges in numerous educational systems through research articles, publications, books, conference proceedings. Two distinct technology categories that have emerged as leaders are virtual reality (VR) and augmented reality (AR), basically to assist students in acquiring the new skill or view the world from a different angle. The primary features of virtual reality are representation in a fictional

environment, immersion in the virtual world, sensory feedback, and interactivity, whereas contextuality—the simultaneous blending of the virtual and real worlds—interactivity, and spatiality in the three-dimensional world are features of augmented reality. Immersion, teamwork, fun, and motivation in the classroom have all been demonstrated to be improved by virtual reality (VR) technology. Several domains, including health applications like surgical education, engineering like robotics, construction, and science like astronomy, have explicitly adopted VR technology. Conversely, augmented reality (AR) is a brand-new educational tool that seamlessly connects virtual objects with the real world by fusing aspects of social, physical, and ubiquitous computing. Students' views of and interactions with the outside world have improved as a result of its utilisation in the classroom. Virtual reality (VR) and augmented reality (AR) have the potential to revolutionize edification by giving students new and interesting ways to interact with and learn from instructional materials (Guray& Kismet, 2023). According to Markets and Markets, released in July 2023, the size of the worldwide market for AR and VR in education was estimated at USD 3.8 billion in 2023 and is predicted to reach USD 14.2 billion by 2028, with a compound annual growth rate of 29.6% expected throughout the forecast period and according to (market.us) news published in April 2024, the Global AR and VR in Education, the market is anticipated to develop at a compound annual growth rate (CAGR) of 20.26% from 2024 to 2033, from a value of USD 11.9 billion in 2023 to over USD 75 billion by 2033. According to Verner et al. (2022), augmented reality (AR) adds digital data to the real world, but virtual reality (VR) provides a totally non-natural experience. In other words, augmented reality is more like the real world than virtual reality. In general, gamified and interactive learning experiences for students may be created using both AR and VR, increasing their enjoyment and engagement with the material (Chan et al., 2022). Academic contributions from AR and VR to education include studies on how effectively these technologies may improve student learning outcomes and the development of creative teaching strategies and lesson plans that take use of these technologies' advantages (Solmaz et al., 2021). It has been shown that kids who use AR and VR technologies show greater levels of interest and engagement and do better on academic work (Alizadehsalehi et al., 2021). In addition, scholars are discovering the probable applications of augmented reality and virtual reality in domains including special education, STEM education, and language learning (Chan et al., 2022). According to research by Allcoat et al. (2021), using these skills as a knowledge tool for students resulted in higher retention than using old-style teaching methods. Virtual reality (VR) and augmented reality (AR) educational experiences are engaging and appealing to a variety of learners, including adults and younger students. They also help to improve focus levels, particularly for younger students, as they study (Ting et al., 2021). The outcomes of (Gargrish et al., 2020) study on secondary school students demonstrated that immersive competences benefit early learners in boosting their focus level and recalling topics for an elongated time.

Additionally, research has shown that VR and AR support the growth of creativity and communication abilities, respectively (Khan et al., 2021b; Schott et al., 2021). It is essential to let children's imaginations run wild, especially while they are inquisitive and developing their problem-solving skills. With the aid of VR and AR technology, imagination may also result in the establishment of young scientists by enabling them to carry out risky and complex activities that are hard to carry out in a real setting. It has been confirmed by Armah and Landers-Potts (2021) that kids who have an imagination are more gregarious than kids who don't. Cognitive abilities, which are often thought to be advantageous for social development, have been

favourably correlated with imaginative abilities. The secure atmosphere offered by VR and AR educational-based apps assisted minimise mistakes and job time for finishing hard activities (Radosavljevic et al., 2020; Zhang et al., 2021). When studying with virtual 3D machines, it makes students feel more at ease. Additionally, students who use the VR and AR software do better than those who complete the same activities using traditional techniques. Pellas (2016) went on to say that students might participate in real-world learning experiences that are not possible in the actual world, such seeing historical locations and travelling to far-off planets, using VR scenario reenactments and simulations. This implies that by providing students with richer and more varied opportunities to investigate knowledge, these learning experiences raise cognitive engagement. Freina and Ott (2015) discovered that students may choose various roles to carry out escape drills by replicating actual school escape events in virtual reality. This kind of behavioural engagement can aid students in improving their mastery of escape procedures and safety awareness. It appears from these publications that virtual reality can improve students' behavioural involvement. Using augmented reality (AR) to bring the virtual world into the real world, where it is transformed into 3D objects, can help students improve their oral expression in language learning (Dhimolea et al., 2022). This approach breaks up repetitive learning and motivates students to study more (Saputro&Saputra, 2015). Within a variety of educational systems, including K–12 education (DegliInnocenti et al., 2019), Unconventional Tutoring (Samosorn et al., 2020), Career Instruction (VE) (Babu et al., 2018), and Work Training (IT) (Delgado et al., 2020), the use of VR and AR technology appears to have a capable future in education and training. The intended learning results might be significantly impacted by the interactive and immersive VR activities (Abulrub et al., 2011; Porumb et al., 2013; Valdez et al., 2013). Furthermore, technology helps teachers visualise the many parables that they usually find difficult to communicate. Better visualization enhanced knowledge and capacity to recall the information taught (Kuna et al., 2023).

### **3. RESEARCH METHODOLOGY**

In this study, many research articles, publications, books, conference proceedings were identified and analyzed, investigating the role of mixing VR and AR knowledges in numerous educational systems, available from 2011 to 2024. This study also reviews the use of Augmented Reality (AR) and Virtual Reality (VR) in education, particularly in the schooling process including its benefits and restrictions through review of literature.

### **4. DIFFERENCE BETWEEN VIRTUAL REALITY AND AUGMENTED REALITY TECHNOLOGY IN EDUCATION**

Technology is not new to education. Over time, a variety of innovations have transformed classrooms, including smart displays, overhead projectors, and blackboards. In the era of digital revolution, we live in today, there is a enthralling new movement of technology innovation in education. Virtual reality (VR) and augmented reality (AR) are two technologies that might completely change the educational landscape. As table 1 below illustrates, virtual reality (VR) and augmented reality (AR) are two sides of the similar coin of developing technologies that share certain individualities but also have some exclusive abilities of their own.

**Table 1. Table: 1 Comparison / Difference Between VR and AR**

Virtual Reality (VR)	Augmented Reality (AR)
Virtual reality (VR) substitutes the real world with a virtual one, which may restrict full integration with the real world. Virtual reality experiences prioritize the creation of realistic simulations and virtual environments.	Thanks to augmented reality's integration with the actual world, students may see and interact with virtual items in their immediate surroundings.
VR is usually only accessible in specific situations due to the need for specialized gear, such as head-mounted displays (HMDs) and motion VR devices, which are less portable and require more processing power.	Numerous devices, such as smartphones, tablets, or specialized AR programs, can be used to access augmented reality experiences. Compared to VR, AR applications are frequently more portable and easily accessible.
With the use of tracking and headgear, virtual reality (VR) seeks to dip the user in a new environment.	The goal of augmented reality (AR) is to develop the real environment with digital objects, pictures, movies, or experiences that are superimposed with 3D models and computer-generated imagery (CGI).

**Source:** Compiled by Researchers

When comparing their efficacy in particular situations, AR and VR provide different ways to learn. Because of these technologies' capacity to provide immersive learning environments, both educators and students have found them to be quite popular. Virtual reality (VR) and augmented reality provide unmatched chances to enhance learning. In fact, students may learn in immersive environments thanks to the combination of AR and VR technologies and sometimes joined together under ER (Extended Reality) technology. Physical textbooks are being replaced with AR. Instead, then hauling around bulky bags, students may bring their iPhones. Schools and colleges can use screens and emergency response devices in place of white/blackboards and banners. Few examples of AR/VR in Education like Skyview – An augmented reality (AR) software called Skyview that takes students on a nighttime sky tour to enhance their erudition practice where students can acquire more about planets, satellites or other astronomy topics and Holo Anatomy - Microsoft developed Holo Anatomy, a VR application, in close cooperation with the Case Western University group. Medical students may investigate human body parts from various perspectives and study human anatomy in great depth and interactively.

## RESULTS

Sometimes learners are not able to understand difficult concepts and theories using conventional learning approaches. Still, VR and AR technologies have effectually solved this question by giving students with immersive understandings like these topics. This method can improve the comprehension and help to grasp the assignments more fully. Accordingly, utilising VR and AR will assist overwhelmed period and expense restrictions. With the help of these technologies, teachers won't have to waste time figuring out how to teach difficult subjects. These tools provide superior visualisation, enabling teachers to close the knowledge gap between abstract and applied ideas while also assisting students in comprehending the assignment and strengthening their understanding. In summary, the integration of virtual reality and augmented

reality technology in teaching can help address many challenges faced by conventional methods of instruction and training. It has a tremendous potential in education business but it is advised that a suitable strategy is established to address the identified hurdles before utilising VR and AR technology in education. Although VR and AR have demonstrated a great deal of promise for improving learning environments, there are a number of drawbacks that need to be taken into account. For example, organisations and educational institutions may find it difficult to purchase and maintain wearable VR and AR technology, such as headsets and controllers, for every learner. Second, creating VR and AR content requires a specialist with the requisite knowledge and abilities in 3D modelling, programming, and subject matter experience (Alfalah, 2018), which could be challenging to organise for the universities. Furthermore, it is imperative that virtual and augmented reality learning experiences closely resemble real-world ones. Failure to deliver a realistic experience may compromise the learning process and have an adverse effect on students.

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