

Augmented Reality in Teaching-Learning: An Innovative Digital Tool for the Twenty-First Century Classrooms

Seema Yadav

Assistant Professor, Department of Education, The Bhopal School of Social Sciences,
Bhopal, M.P., India

Email: seemayadav1edu@gmail.com

Abstract

Innovative technical tools like augmented reality (AR) and virtual reality have been made possible by technological advancement and device computational power. AR is a technology tool with amazing pedagogic potential that enables the creation of innovative learning environments. The successful use of AR in the classroom can assist students in several ways and result in fruitful learning experiences. The use of AR technology can also be used to design more interesting and appealing educational experiences. Technology such as augmented reality may immediately produce learning experiences for students, which makes it a highly helpful tool for the execution of educational activities. The use of augmented reality in the classroom has tremendous potential, and it can be successfully integrated with existing teaching and learning methods. It is necessary to deploy innovative pedagogies that blend formal and casual learning and enable individualized learning. Education professionals need to reconsider how they employ conventional pedagogies to support the development of skills and competencies for lifelong learning. The education industry could be transformed with the effective and on-going use of digital learning tools.

Keywords: Technology, Augmented Reality, Digital Learning, Innovative Technologies, Teaching-Learning

Introduction

Education has been forced to adapt new learning models as a result of the development of innovative educational approaches as a result of the advent of information technology and digitization. Additionally, all educational institutions were compelled to make the changeover to online learning right away due to pandemic limitations and to aid in containing the virus's (COVID-19) spread (Criollo-C et al., 2021). These educational models should support current learning processes and encourage the distribution of digitized instructional information (Criollo-C et al., 2021). Our needs for education in the future cannot be met by the conventional, constrained competency-based

approach (David, 2017). Education's primary goal today is to prepare students for the complicated and ever-changing nature of the workforce. The ability to adjust educational content for students to enhance their practical abilities using augmented reality technology emphasizes that while theoretical knowledge is the foundation, skills acquired in a practical setting are always required (Criollo-C et al., 2021). By encouraging students' abilities to explore, create, interact, connect, reflect, and share knowledge inside online contexts, digital tools in the form of social media further expand the possibilities for developing learner-centered spaces (Blaschke & Hase, 2019). Utilizing technology is hoped that it would encourage students'

imagination and creativity in the subject matter and enable them to take charge of their learning at their speed and along their course (Bistaman, Idrus, & Rashid, 2018a). The current state of technology advancement makes it possible to apply innovative learning aids in a variety of sectors, particularly in education. To improve the teaching and learning process, several technologies have been adopted in the educational sector. The use of augmented reality (AR) in education offers fresh approaches and has a lot of pedagogical potential (Bistaman et al., 2018a). To effectively teach students and provide better techniques to enhance their learning experiences, instructors must choose the best strategy (Bistaman et al., 2018a). The adoption of augmented reality in education has grown, and stakeholders are increasingly drawn to it because it is unique and has the potential to raise educational standards. The use of augmented reality (AR) media as a supplement or intermediary tool has become commonplace. The use of augmented reality (AR) media as a tool or an intermediate in daily life is now widespread (Rusli, Nalanda, Tarmidi, Suryaningrum, & Yunanda, 2023). As an emerging technology, augmented reality (AR) has shown a wide range of benefits for teaching foreign languages, including fostering motivation, content memorization, and contextualised learning (Manna, 2023).

Technology in Teaching-Learning: Technology Integration in Education

The twenty-first century provides a boundary-less existence, globalization, internationalization, and the explosive growth of information and communication technologies (Nurhasanah, Abdurrahman, Andra, & Herlina, 2021a). Technology advancements and device computing power have made it possible to produce cutting-edge technological

tools like augmented reality (AR) and virtual reality (VR) (Criollo-C et al., 2021). During the fourth industrial revolution, technology advanced very quickly, which led to changes in the educational system and other advances worldwide (Nurhasanah et al., 2021a). The results of current technological integration into education reveal a positive impact on learning and teaching outcomes. One of the pillars of contemporary society is education, which attempts to equip students with the skills necessary to participate fully in a society that is currently more focused than ever on technological advancement (Criollo-C et al., 2021). Teachers now have a unique opportunity to assist students in acquiring lifetime learning abilities thanks to the trends of learner-centered teaching and pervasive classroom technology use (Blaschke & Hase, 2019). There has been a movement towards more learner agency in both formal and informal educational settings as a result of the substantial improvement in learning affordances brought about by technological advancements. With the learner at the center of the learning process and as an active agent of learning rather than a passive user of information, this has presented a challenge to educators regarding how they navigate the learning process (Blaschke & Hase, 2019). Emerging technologies should be used in educational settings to present course content that is compatible with human cognition since they are aware of how important it is for students today to acquire, store, and apply information (Bistaman et al., 2018a).

Dealing with digital natives presents issues for teachers in the modern world. The demand for adopting technology in education is rising as a result of the explosion and quick growth of information technologies that can be used in instruction. This is done to encourage students to engage in active

learning and motivate them to achieve an effective learning process (Alkhatabi, 2017). To integrate innovative and new technologies into classes, which have the potential to significantly improve student learning and engagement, teachers must devote a significant amount of personal time to becoming familiar with them. The current rate of technological advancement, which is boosting the web's interactivity and media content and raising the caliber of distribution platforms, gives the perfect conditions for a rise in the use of e-learning tools and solutions (Alkhatabi, 2017).

Augmented Reality: The Concept and Meaning of Digital Innovative Tool

The definition of augmented reality (AR), a concept that has been in development since the turn of the 20th century, is the superimposition of virtual elements in a real environment (Criollo-C et al., 2021). The term "augmented reality" (AR) refers to a set of tools that enable a person to observe one or more virtual items in a real-world setting. Instead of being a specific technology, augmented reality might be thought of as a concept. The idea of augmented reality (AR) should be imagined beyond technology alone and should not be limited to any one form of technology. The use of augmented reality (AR) technology enables people to perceive objects in their natural environments, something that is otherwise impossible (Bistaman et al., 2018a). An artificial layer is placed on top of real-world photographs using augmented reality (AR), a new technology that is also applied in the field of education (Karagozlu, 2021). For all educational applications and possibilities, augmented reality (AR) is the best option. The advancements in technology nowadays make me conscious of the need to better educational sectors through efficient means. According to the studies, AR can

engage, stimulate, and inspire students to examine the course material from several perspectives (Bistaman et al., 2018a). The term "augmented reality" (AR) refers to a live, direct, or indirect view of a physical, real-world environment, with computer-generated sensory input such as sound, video, graphics, or GPS data enhancing some aspects of the environment. Virtual and real worlds can seamlessly interact with each other thanks to augmented reality (AR) interfaces, which also provide a tangible interface metaphor and a way to switch between them (Bistaman et al., 2018a). Virtual Reality (VR), also known as Mixed Reality, is an extension of augmented reality (AR). The use of computer-generated images or objects blended with real-world surroundings is known as augmented reality (AR). Numerous industries, including engineering, industrial design, the military, medical science, and education, have already used this technique (Bistaman et al., 2018a). Technology that uses augmented reality can directly create learning experiences for students, which is particularly helpful for the execution of educational activities (Hidayat, Sukmawarti, & Suwanto, 2021). With the development of numerous gadgets and smart device apps, augmented reality (AR) technology has been expanding alongside different kinds of hardware (Hanid, Haruzuan, Said, & Yahaya, 2020). The use of augmented reality (AR) in the classroom can promote student engagement, improve communication between teachers and students, and support learning activities (Nurhasanah, Abdurrahman, Andra, & Herlina, 2021b). As Industrial Revolution 4.0 takes hold, the learning environment is undergoing fast change. In education, augmented reality is one of the hottest technologies. The usage of virtual objects that are seamlessly integrated into the actual world and appear in the same location in real-time is made possible by the technology known as augmented reality

(Hanid et al., 2020). The success of augmented reality (AR), particularly in the sphere of education, has led to a considerable increase in the use of new technologies in recent years (Alkhatabi, 2017). Technology is advancing in today's world across many industries, including education, even at the primary level. The application of technology in elementary schools, including Augmented Reality, is still being refined. With the aid of augmented reality technology, virtual items in 2D and 3D can be seen in real-time (Hidayat et al., 2021).

This technology tool is useful in the classroom since it promotes learning by making it more interactive and dynamic. Additionally, studies have demonstrated how powerfully successful employing augmented reality in educational settings is at enhancing student learning (Criollo-C et al., 2021). With the use of this application, teachers can assist students in teaching subjects in which they are not currently able to obtain first-hand experience in the actual world and improve communication between them (Bistaman et al., 2018a). Augmented reality (AR) is a technology that alters reality by fusing real-world visuals with digital elements and enhances how reality is perceived. Regarding augmented reality techniques, both pupils and teachers express generally favorable opinions (Karagozlu, 2021). The utilization of things in the real-world environment is made possible by computer-generated technology known as augmented reality (AR) (Bistaman et al., 2018a). Both positive and bad effects may result from teaching basic education students with augmented reality technologies. The demands and preparation of the pupils, as well as the readiness of the current infrastructure and instructor skills, must still be taken into account when using augmented reality in the classroom (Hidayat et al., 2021). By utilizing proper instructional strategies, AR may provide students

with numerous benefits and lead to effective learning experiences. The AR technology also gives the opportunities to create educational experiences that are more engaging and attractive. The application of augmented reality improves motivation, engagement, and interaction with the environment and other people while also speeding up conceptual learning and memorization (Mozaffari & Hamidi, 2023).

Augmented Reality in Teaching-Learning: Employing Advanced Innovative Technology in Classroom

The use of augmented reality (AR) in education offers many advantages, including improved engagement and interaction, and it can lessen the negative impacts of the interruption of face-to-face instruction (Criollo-C et al., 2021). Several elements need to be available for the AR application to be used in education successfully for both teaching and learning (Bistaman et al., 2018a). The use of augmented reality in the educational field has grown, and stakeholders are increasingly drawn to its novelty as a way to raise educational standards (Hidayat et al., 2021). Higher education uses AR to help students become more proficient and knowledgeable in disciplines like electrical theory, agronomy, chemistry, biology, geometry, and technological themes (Criollo-C et al., 2021). Since theoretical knowledge is the foundation, but practical skills are constantly required, augmented reality technology allows for the adaptation of educational content targeted at students to develop their practical skills (Criollo-C et al., 2021). AR can help to promote student-centered learning, pique students' interests and curiosities, improve their cognitive, emotional, and psychomotor processes, and increase their involvement in the information-seeking process. Augmented reality has successfully improved students'

visualisation skills and fostered a better grasp of content. Hence, it is advised that educators incorporate it in their teaching and learning (Ali, Johari, & Ahmad, 2023). Since it enables the student to move beyond a tool connected to a virtual classroom and towards immersion in surroundings with high contextual fidelity, augmented reality (AR) has been able to establish itself as a learning resource that goes beyond a tool linked to a virtual classroom (Chamorro-Atalaya et al., 2023). An application created using augmented reality serves as a teaching tool for elementary school pupils to understand the different parts of the hand. With this educational tool, it is believed that instructors will benefit from having an application that serves as a teaching tool for primary school pupils learning about the human body's parts (Rusli et al., 2023).

Augmented reality employs interactive learning, game-based learning, collaborative learning, and experiential learning for the learning process (Hanid et al., 2020). The teachers and students agreed that implementing AR techniques had a beneficial impact on how well they understood science concepts, provided a visual introduction to the subject, and facilitated in-class discussion (Karagozlu, 2021). Audio elements would make the program more appealing and simpler to use, according to both the students and the professors (Karagozlu, 2021). The usage of computer-generated systems for augmented reality (AR) enables users to observe real-world surroundings with virtual things composited onto them (Bistaman et al., 2018a). The utilization of innovative educational tools like augmented reality is made possible by the development of technology. A subset of virtual reality is augmented reality (AR). Users of AR can view the actual environment with virtual things superimposed or blended in with it (Bistaman et al., 2018a).

Although augmented reality (AR) has the potential to improve educational outcomes, its practical implementation in the classroom must take into account domain-specific, pedagogical, and psychological factors. When creating and incorporating an AR learning environment, tactics like collaborative learning were taken into account. Collaboration is the act of working together from one party to another, where they can speak with each other to learn and gain from one another (Bistaman et al., 2018a). Teachers must take into account integrating this cutting-edge technology to support and improve learning by utilizing computers, multimedia resources, the internet, simulation games, and immersive technology like 3D virtual worlds and Augmented Reality (Bistaman et al., 2018a).

In comparison to other forms of technology like multimedia, gaming, and online learning, augmented reality technology offers more promise. Even though augmented reality has created new potential to improve the educational system, it is up to educators to recognize emerging technologies and ensure that education is getting better (Bistaman, Idrus, & Rashid, 2018b). Augmented Reality (AR) is an interactive media that combines developments in image processing, tracking technology, and natural human-computer interaction. To create the educational application utilizing this methodology for actual use in classrooms, domain-specific, pedagogical, and psychological issues must be taken into consideration (Bistaman et al., 2018a).

Due to its capacity to engage pupils in lifelike experiences, augmented reality is attracting scientific interest (Alkhatabi, 2017). To have an impact on raising the standard of the learning process, the technologies being utilized, especially Augmented Reality, must be integrated with the proper learning methodologies.

The success and usefulness of the technology support utilized, such as augmented reality in education, can be influenced by the choice of appropriate learning methodologies (Hanid et al., 2020). An emerging technology is augmented reality. AR-based programs are employed more and more in education and training due to their flexibility in fusing real-world and virtual worlds. Different ways of distributing educational material and improving student experiences are made possible by the usage of this technology.

Advantages of Augmented Reality in Teaching-Learning

The usability results demonstrate that NetAR is well-liked by users and has a beneficial impact on education (Criollo-C et al., 2021). The employment of a tactile interface metaphor for object manipulation could be made possible by AR, which could provide seamless interaction between real and virtual environments (Alkhattabi, 2017). AR systems layer other useful 3D virtual items onto the real world so that users can interact with them. With augmented reality, one may interact with all of the virtual information that is overlaid while never losing sight of the real world (Criollo-C et al., 2021). The use of augmented reality in teaching facilitates the transfer of new concepts to students, cuts down on class planning time, and enhances teacher-student engagement (Karagozlu, 2021). Due to its advantages, augmented reality (AR) and mobile learning could be the solution to this modern instructional model, facilitating understanding of instructional content and boosting students' enthusiasm and interest (Criollo-C et al., 2021). Due to its variety of applications for various educational levels and disciplines, augmented reality is attracting a lot of attention from educational institutions and professionals in the field of education

(Criollo-C et al., 2021). In the field of mobile technology, augmented reality has become increasingly significant in recent years due to its ability to make teaching and learning processes easier. An augmented reality prototype has been successfully developed, and this will help to improve instruction at the Universidad de Ciencias y Humanidades because this augmented reality prototype is appropriate for classes in biology, human anatomy, human physiology, microbiology, and parasitology that are part of the professional school of nursing because it teaches through cognitive processes (Morales, Andrade-Arenas, Delgado, & Huamani, 2022).

Applications for numerous academic fields, including mathematics, mechanics, physics, and urban planning, among many others, have proliferated thanks to the adaptability with which this technology is being created (Criollo-C et al., 2021). The augmented reality application promotes learning, provides a visual topic introduction, increases the permanence of the topics taught, adds to learning through enjoyment, and positively influences attitudes toward the subject. In their learning process, students get more enthusiastic (Karagozlu, 2021).

Numerous efforts in the fields of augmented reality and mobile learning have been created to create cutting-edge teaching and learning approaches for a variety of academic fields and levels (Criollo-C et al., 2021). The professors and students agreed that AR techniques enhanced the learning of science concepts, provided a visual topic introduction, and facilitated in-class discussion (Karagozlu, 2021). The use of augmented reality applications will transform the way that education is delivered, allowing for the creation of real-world learning environments that are conducive to a variety of learning preferences (Bistaman et al., 2018a).

An emerging technology is augmented reality. AR-based programs are being utilized more frequently in education, particularly medical education and training, because of their versatility in merging physical and virtual environments. This technology is used to deliver educational material and improve student experiences in a variety of ways (Dhar, Rocks, Samarasinghe, Stephenson, & Smith, 2021).

Learning advancements in augmented reality applications develop into fully functional tools that can serve both teachers and students (Criollo-C et al., 2021). The integration of augmented reality applications in the classes was beneficial for grabbing students' attention and maintaining it throughout the lesson (Karagozlu, 2021). The potential of augmented reality technology to increase student interest and motivation while also supporting the teaching and learning process in a classroom (Bistaman et al., 2018a). Using Augmented Reality (AR) apps in education, in particular, offers a great deal of promise to improve teaching and learning while also fostering collaborative tasks between teachers and students (Bistaman et al., 2018a). Primary school teachers have a high acceptance rate for AR and are willing to employ it. The findings also showed that strong motivators might be created by establishing a solid human infrastructure, a suitable ICT infrastructure, and IT skills (Alkhatabi, 2017). In order for students to compete worldwide and keep up with the times, teachers must be able to increase the quality of the learning process in a variety of ways, one of which is by implementing AR-based learning techniques (Nurhasanah et al., 2021b).

(Ropawandi, Halim, & Husnin, 2022) indicated that augmented reality technology increased students in the experimental group's knowledge of electrical principles compared to the

control group, with a significantly substantial difference between the two groups. This study helps advance augmented reality (AR) technology in education, particularly as it relates to the teaching and understanding of abstract physics ideas.

Conclusion

The twenty-first century brings with it the possibility of living in a world without borders, globalization, internationalization, and the quickening development of information and communication technologies. Technology such as augmented reality (AR) makes it possible to create innovative learning environments and has enormous pedagogic potential. Teachers now have a unique chance to help students develop skills for lifetime learning thanks to the trends of learner-centred teaching and pervasive technology use in the classroom. It has a great deal of promise to improve teaching and learning while also fostering collaboration between teachers and students when Augmented Reality (AR) applications are used in education. Innovative learning tools are now possible thanks to technological advancements in education. Numerous elements, especially conventional teaching techniques and technological approaches using AR, must be taken into account to ensure the use of this technology in education is done more successfully. AR technology has matured to the point where it can be applied to a much wider range of application domains, and education is an area where this technology could be especially valuable. AR can assist students in many ways and result in productive learning experiences when used with the right educational strategies. Another opportunity provided by AR technology is to design more interesting and appealing teaching experiences. The use of augmented

reality in education has great potential since it can be successfully integrated into both teaching and learning. The implementation of new pedagogies, which promote personalization of learning and integrate both formal and informal learning, is crucial. As they work to encourage the development of skills and competencies for lifelong learning, educators must re-evaluate their use of traditional pedagogies. The education industry may undergo reform if digital learning tools are used effectively and consistently. Augmented reality (AR) is revolutionizing teaching and learning by enhancing traditional educational methods with interactive,

immersive experiences. AR technology overlays digital content, such as 3D models, animations, or information, onto the real world through devices like smartphones or AR glasses. This dynamic integration of digital elements into the physical environment enables students to engage with complex concepts in a more visual and interactive manner, making learning more engaging and effective. AR can be used in various subjects, from history to science, and offers opportunities for hands-on exploration and problem-solving, ultimately fostering deeper understanding and retention of knowledge.

References

- Ali, D. F., Johari, N., & Ahmad, A. R. (2023). The effect of augmented reality mobile learning in microeconomic course. *International Journal of Evaluation and Research in Education*, 12(2), 859–866. <https://doi.org/10.11591/ijere.v12i2.24943>
- Alkhattabi, M. (2017). Augmented reality as e-learning tool in primary schools' education: Barriers to teachers' adoption. *International Journal of Emerging Technologies in Learning*, 12(2), 91–100. <https://doi.org/10.3991/ijet.v12i02.6158>
- Bistaman, I. N. M., Idrus, S. Z. S., & Rashid, S. A. (2018a). The Use of Augmented Reality Technology for Primary School Education in Perlis, Malaysia. In *Journal of Physics: Conference Series* (Vol. 1019). Institute of Physics Publishing. <https://doi.org/10.1088/1742-6596/1019/1/012064>
- Bistaman, I. N. M., Idrus, S. Z. S., & Rashid, S. A. (2018b). The Use of Augmented Reality Technology for Primary School Education in Perlis, Malaysia. *Journal of Physics: Conference Series*, 1019(1), 0–9. <https://doi.org/10.1088/1742-6596/1019/1/012064>
- Blaschke, L. M., & Hase, S. (2019). Heutagogy and digital media networks: Setting students on the path to lifelong learning. *Pacific Journal of Technology Enhanced Learning*, 1(1), 1.
- Chamorro-Atalaya, O., Morales-Romero, G., Quispe-Andía, A., Quispe-Guía, S., Guía-Altamirano, T., Auqui-Ramos, E., Arévalo-Tuesta, J. A. (2023). Contribution of Augmented Reality in Teaching and Learning, in the Midst of COVID-19: Systematic Review. *International Journal of Learning, Teaching and Educational Research*, 22(2), 302–322. <https://doi.org/10.26803/ijlter.22.2.17>
- Criollo-C, S., Abad-Vásquez, D., Martic-Nieto, M., Velásquez-G, F. A., Pérez-Medina, J. L., & Luján-Mora, S. (2021). Towards a new learning experience through a mobile application with augmented reality in engineering education. *Applied Sciences (Switzerland)*, 11(11). <https://doi.org/10.3390/app11114921>
- David, S. (2017). Practical heutagogy: Promoting personalised learning in management education. *Adult Learning*, 31(4), 161–174. <https://doi.org/https://doi.org/10.1177/1045159520905364>
- Dhar, P., Rocks, T., Samarasinghe, R. M., Stephenson, G., & Smith, C. (2021). Augmented reality in medical education: students' experiences and learning outcomes. *Medical Education Online*. <https://doi.org/10.1080/10872981.2021.1953953>

- Hanid, M. F. A., Haruzuan, M. N., Said, M., & Yahaya, N. (2020). Learning strategies using augmented reality technology in education: Meta-analysis. *Universal Journal of Educational Research*, 8(5 A), 51–56. <https://doi.org/10.13189/ujer.2020.081908>
- Hidayat, Sukmawarti, & Suwanto. (2021). The application of augmented reality in elementary school education. *Research, Society and Development*, 10(3), e14910312823. <https://doi.org/10.33448/rsd-v10i3.12823>
- Karagozlu, D. (2021). Creating a sustainable education environment with augmented reality technology. *Sustainability (Switzerland)*, 13(11), 1–15. <https://doi.org/10.3390/su13115851>
- Manna, M. (2023). Teachers as augmented reality designers: A study on Italian as a foreign language teacher perceptions. *International Journal of Mobile and Blended Learning*, 15(2), 1–16. <https://doi.org/10.4018/IJMBL.318667>
- Morales, S. A. H., Andrade-Arenas, L., Delgado, A., & Huamani, E. L. (2022). Augmented Reality: Prototype for the Teaching-Learning Process in Peru. *International Journal of Advanced Computer Science and Applications*, 13(1), 806–815. <https://doi.org/10.14569/IJACSA.2022.0130194>
- Mozaffari, S., & Hamidi, H. R. (2023). Impacts of augmented reality on foreign language teaching: a case study of Persian language. *Multimedia Tools and Applications*, 82(3), 4735–4748. <https://doi.org/10.1007/s11042-022-13370-5>
- Nurhasanah, S., Abdurrahman, A., Andra, D., & Herlina, K. (2021a). Augmented Reality (AR) in Physics Learning: Opportunities to Improve Teacher and Student Interaction in Online Learning. *Indonesian Journal of Science and Mathematics Education*, 4(2), 145–157. <https://doi.org/10.24042/ijsme.v4i2.8486>
- Nurhasanah, S., Abdurrahman, A., Andra, D., & Herlina, K. (2021b). Augmented Reality (AR) in Physics Learning: Opportunities to Improve Teacher and Student Interaction in Online Learning. *Indonesian Journal of Science and Mathematics Education*, 4(2). <https://doi.org/10.24042/ijsme.v4i2.8486>
- Ropawandi, D., Halim, L., & Husnin, H. (2022). Augmented Reality (AR) Technology-Based Learning: The Effect on Physics Learning during the COVID-19 Pandemic. *International Journal of Information and Education Technology*, 12(2), 132–140. <https://doi.org/10.18178/ijiet.2022.12.2.1596>
- Rusli, R., Nalanda, D. A., Tarmidi, A. D. V., Suryaningrum, K. M., & Yunanda, R. (2023). Augmented reality for studying hands on the human body for elementary school students. *Procedia Computer Science*, 216(2020), 237–244. <https://doi.org/10.1016/j.procs.2022.12.132>