

## SUCCEEDING GENERATION OF AUGMENTED REALITY TECHNOLOGY IN MEDICAL EDUCATION

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### ABSTRACT

This review discussed augmented reality (AR), a new emerging technology seen everywhere in our daily lives. Augmented reality is widely used in healthcare, advertising, and engineering industries. It seems like the world will combine the real and the virtual worlds. From an educational perspective, augmented reality allows multimedia materials. This review aimed to provide reported trends and critical synthesis to identify gaps in existing literature and research areas. The PubMed, Web of Science, and Discover databases were used as sources for the review of the literature. This review included published studies reported in peer-reviewed research journals between 2019 to 2021. Augmented reality-based learning programs are widely used in medical schools around the globe because it provides distinct learning sources, such as remote learning and simulation-based learning. The benefits have increased in the recent COVID-19 pandemic, making it possible to give online. Education systems, including medical institutions, used augmented reality for the experiments and training of their students. This review also discussed how AR can improve the knowledge and skills of medical students.

**Key Words:** Augmented Reality, medical students', medical education, virtual reality

### INTRODUCTION

Augmented reality (AR) is a subset of mixed reality that deals with real-world experiences to build digital methods or information. Barsom et al. 2016, mentioned that AR is an essential virtual reality. In practice, this is usually accomplished with tablet-based devices or headset devices (such as smartphones) in which the virtual objects are created surrounded by the real world. In addition to the auditory and haptic visual AR provides, it is also used for feedback which information is used in education to improve reality (1). The mixed reality allows and can switch the level of interaction experience to present the partial augmentation of the real world. The AR differs from virtual reality because its background is designed with computation. Still, AR and VR are at opposite ends of the assorted actuality spectrum. The field of AR emerged nearly two and a half decades ago (2). Thus it is a relatively new technology which is growing very fast and being used for educational purposes as well. It is also used in medical education and medical students' training so that they can understand easily. Students get a good experience and improve their learning content. AR can also be used to present complex medical concepts and data in an interactive way to make it understandable. For example, AR can be used to create 3D models of organs or organ systems, allowing students to visualize and interact with them in a previously impossible way. Additionally, AR can be used to display medical images such as X-rays, CT scans, or MRI scans in a way that provides greater depth and detail than conventional 2D images. One of the significant advantages of AR technology in medical education is its ability to provide a safe learning environment without the risk of harming patients. Students can practice procedures and gain experience in a controlled environment before moving on to actual patient care. AR technology can also

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provide an immersive learning experience, allowing students to explore and interact with virtual anatomical models, surgical simulations, and medical equipment.

Furthermore, AR technology can facilitate remote learning and collaboration, allowing students to interact with instructors and peers in real time, regardless of their physical location. AR technology can also provide instant feedback, enabling students to assess their performance and improve their skills. Overall, the integration of AR technology in medical education holds tremendous potential to transform how students learn, practice, and acquire skills in healthcare. This review discusses essential practical aspects of the uses of AR in medical education in light of existing literature.

### **A brief history of the use of augmented reality in medical education**

Several programs have been successfully implemented using AR technology in medicine. These are broadly classified into two subgroups. The first involves treatment programs that assist patients and practitioners in a hospital or clinical setting, such as those used in therapeutics, rehabilitation, or surgical procedures. The second category contains exercise plans to improve educational institutes' training and awareness outcomes (3). This analysis focuses on these two aspects to evaluate the future usage of AR and highlight the need to develop and design other programs to improve learning and get suitable outcomes with this technology.

### **Main functions of augmented reality**

The AR is an emerging technology to generate real-world to virtual content; in other words, it is computer-generated content that improves the perception of the real world (4). Azuma et al. defined certain characteristics that are accepted to define AR systems (5-7).

1. It mixes the existent world and simulated structure
2. They are interactive in real-time.
3. Enrolled in three dimensions.

The basic idea behind AR was to mix the view of the real world with the virtual layer to introduce the digital world. The virtual content can entice senses like touch, smell, hearing and sight (8, 9, 10).

The AR technology enhances the physical world features through a program application that utilizes one or more components (11). The program must be installed on the device before developing any AR image. There are two main types of AR computer execution: marker-based AR and markerless AR (12). Markerless AR employs 2D or 3D images, such as a sofa or a physical object like a building or people, which the AR computer program application can identify. Upon receiving input from the marker or object, the AR computer program application generate augmented virtual content and projects it onto the specified object (13-14). This immersive experience makes the additional information appear within the environment, creating an enhanced reality for the user(Figure 1).

### **Materials and Methods for literature review:**

This narrative review used PubMed, Google Researcher, and Scopus search engines. The keywords used for the literature search included "augmented reality", "therapeutic instructions", "understudy experiences", and "learning outcomes". The articles published in English between January 2019 till December 2021 were selected.

### **Related Work:**

The AR-based medical programs have improved student experiences and learning outcomes. The AR-based training has the potential to viably and productively get restorative experts ready to practice in the real world (15). AR programs for learning in medicine are used to enhance learners' encounters, in

expansion to giving a secure instructive environment and tending to particular proficient skills, as described in Figure 2.

Augmented reality has been found to provide a highly positive subjective experience for learning and can also be used for enjoyable and entertaining purposes. Games like Pokémon Go that utilize AR has become famous for the same reasons (16).

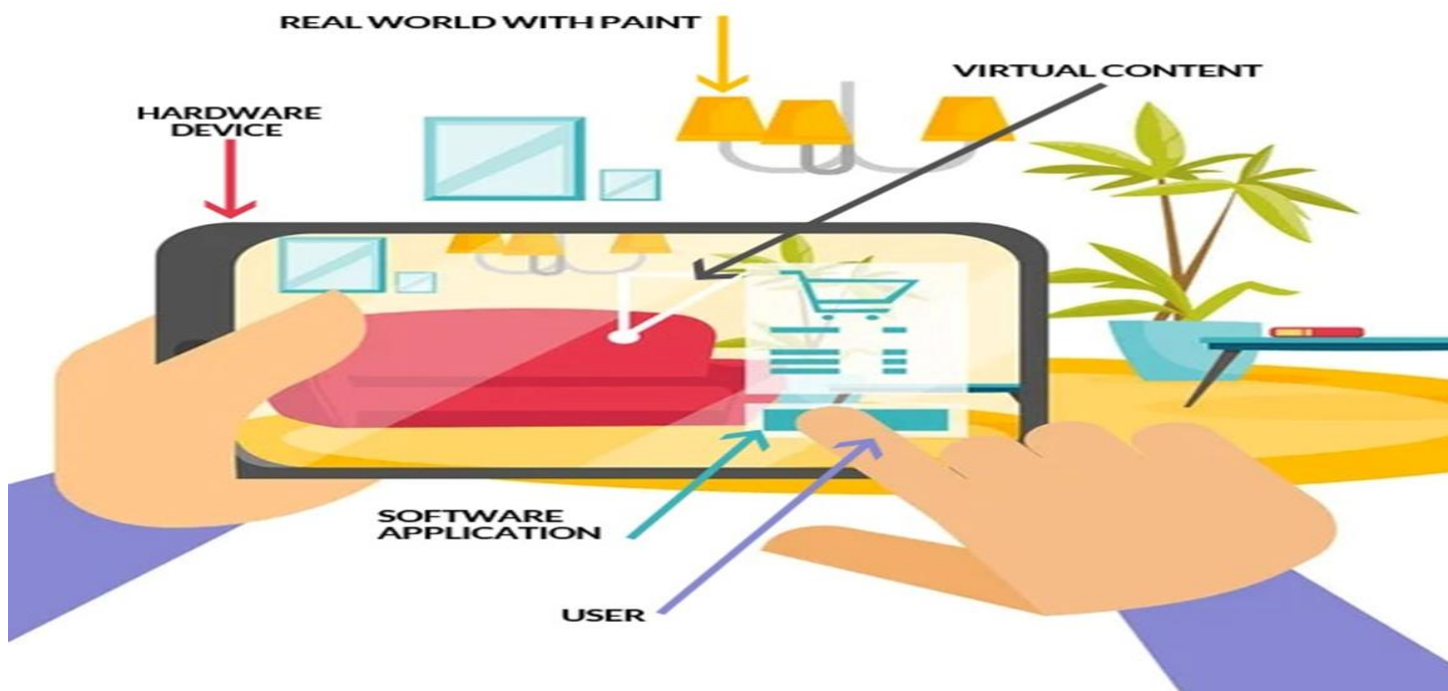
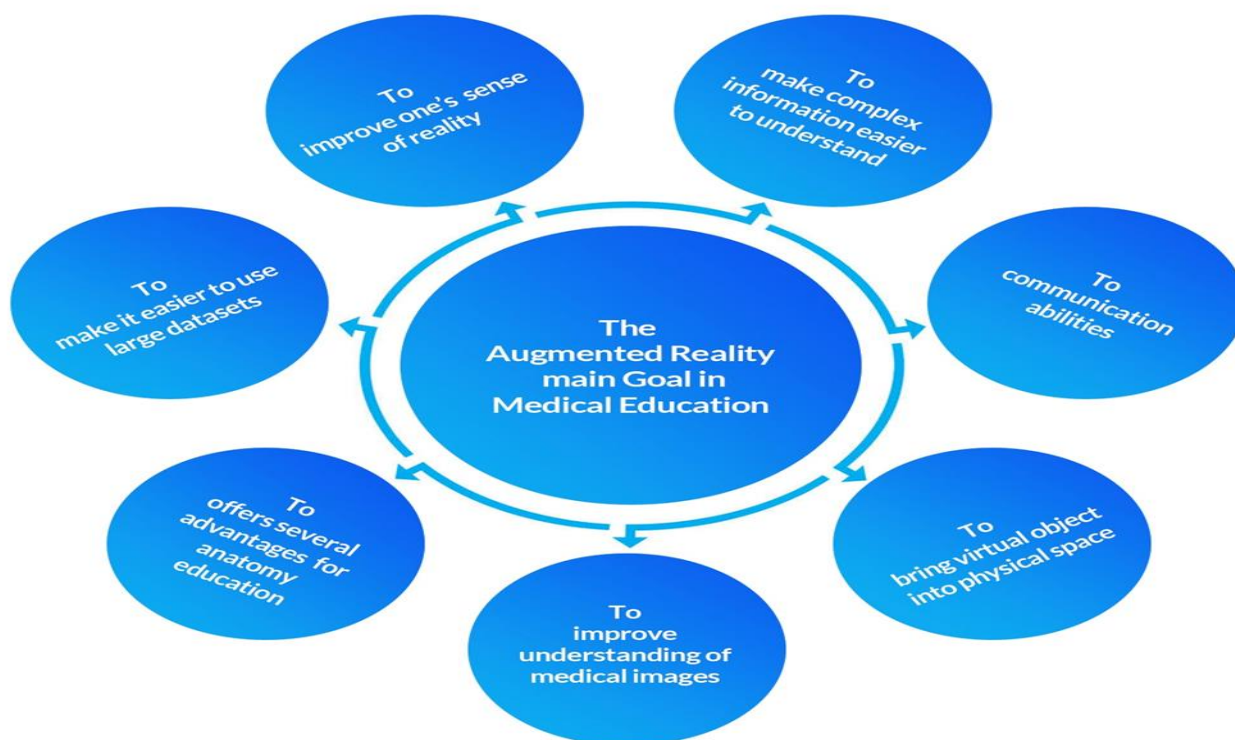


Figure 1. Augment the physical world- A program application that employs one or more of different equipment components



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**Figure: 2. The primary objectives used in AR in medical education perspective**

Additionally, AR can potentially improve the delivery, presentation, and utilization of sensory systems in learning, three critical components of Mayer's cognitive theory of multimedia learning (17, 18). Students often report feeling more confident in their learning when using AR compared to conventional approaches, such as flashcards, due to their high level of digital literacy and familiarity with tablets and smartphones (19). Students of all levels are well versed in using devices for virtual reality for self-learning. The non-headset virtual reality programs show less negative effects, so VR still provides learning benefits. Moro and colleagues demonstrated that the structural anatomy runs on tablets using VR headsets achieved good learning outcomes in terms of anatomical test results. However, the AR tablet version showed fewer side effects such as dizziness, headache, discomfort and eye problems like blurred vision (20). The studies have confirmed that the AR-enhanced learning exercises were more likely to enhance student's theoretical knowledge and commonsense aptitudes resulting in improved examination results. AR-based learning prepares results in key zones, taking counting proficient information, cognitive and down-to-earth aptitudes, social abilities, advancement, competence, and inventiveness into account (21).

It is also reported that AR-based programs influence students' learning outcomes and experiences in association with the information and understanding, commonsense abilities, and social aptitudes domains of influence (Figure 3).





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### **Figure 3. AR-based programs affect students' learning outcomes and experiences in connection** **Use AR to visualize human anatomy and Results**

In depth understanding of anatomy is essential for medical students to understand physiological basis and pathological processes. Thus crucial for practising medicine (16). Dissection of cadavers was commonly used to teach anatomy in the past. To strengthen the learning of human body structure through visual and material encounters, anatomical disintegration is into sequential divisions of tissue layers and particular structures by evacuation of the territorial fat and connective tissue (17). Dismemberment lessons are helpful in a learning strategy since they offer a 3D picture of human structures. It advances information by providing a comprehensive set of anatomical structures and their relationships within an entire organism (18). However, this training method is rather expensive.

Furthermore, no reliable large-scale data is currently available to support the efficiency of dissection classes in teaching anatomy (17). A massive quantity of knowledge on human anatomy and biological function is part of medical education (22). Although the creation of numerous digital systems, such as "virtual cadavers," has tremendously improved recently. AR has enabled medical students to improve their therapeutic understanding with advanced anatomical portrayal from all points, with a more comprehensive view typically differentiated from the real world accessed through a computer mouse and keyboard and operated on the computer screen (23).

#### **Challenges and future work**

The utilization of AR platforms in medical education has advanced dramatically since they were initially used to treat orthopaedic problems. The cost of creating these interactive platforms is one of the most significant issues in the higher education sector (19). The high cost and the shortage of resources to satisfy the demands of the increasing student population hinder their use in medical education. Educators' largest challenge is ensuring that all children have equitable access to this digital technology. Along with the growing issue of social isolation linked to digital learning, the limited technology requirements for using AR in the classroom are another critique (21, 22). However, further developments in this area may benefit teaching students about subjects like human anatomy and physiology. For example, reading and visualizing information about nerve impulses and brain activity can help students retain information and better grasp human body physiology. It will be easier to combat the issue of separation that these AR stages may create for learners. These AR-interfaced books are a fascinating tool for students and instructors, providing a break from the static and gloomy text-only centred learning tool that standard reading material offers.

The emergence of AR has created exciting opportunities for medical educators to develop engaging and immersive educational programs that enable students to learn and experience the learning content. The COVID-19 pandemic has accelerated the adoption of digital teaching tools worldwide, emphasizing the importance of digital technologies such as AR in ensuring uninterrupted student learning. Using digital learning tools has the potential to revolutionize medical education and enhance the learning experience for students.

#### **CONCLUSION**

The AR is widely used in various industries, including healthcare, engineering, entertainment and defence. Nowadays, the world combines the real and the virtual worlds. In educational perspective, the AR allows multimedia materials. Medical education has also shown a significant advancement by using

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AR where students learn basic sciences and clinical sciences more comprehensively. More robust studies directly comparing conventional and AR-based teaching methods will be required to make a firm conclusion.

**CONFLICT OF INTEREST:** Authors declare no conflict of Interest

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