KnE Social Sciences

The 1st International Conference on Creative Design, Business and Society (1st ICCDBS) 2023

KNE Publishing

Research Article

Augmented Reality as an Assistive Tool for Learning How to Use Medical Devices

Ahmad Rieskha Harseno[1]*, Djoko Kuswanto[1], MY Alief Samboro[1], Gunanda Tiara Maharany[1], Irna Arlianti[1], Ahmad Nur Firmansyah[1], Rahmania Almira Fitri[2], Aris Kurnia Wicaksono[3], and Laurensius Windy Octanio Haryanto[4]

[1]Institut Teknologi Sepuluh Nopember, Indonesia
[2]Universitas Aisyiyah Bandung, Indonesia
[3]Universitas Muhammadiyah Surabaya, Indonesia
[4]Institut Teknologi Telkom Purwokerto, Indonesia

ORCID
Ahmad Rieskha Harseno: https://orcid.org/0009-0007-4041-6050

Abstract.
In education, especially in medicine and medical technology, augmented reality (AR) is a promising innovation that can support and enrich the learning process. This technology offers the ability to present complex information on medical devices more interactively, enhance understanding, and provide a practical experience as an alternative to using real devices. AR can be integrated into the process of learning how to use medical devices. In particular, AR can improve information retention, facilitate understanding of technical concepts, and reduce errors when students use medical devices in simulations. It also allows students to practice in a safe environment before dealing with real situations. Despite its great potential, the application of AR in the learning process of medical devices also has several challenges. The need for infrastructure and compatibility is one barrier from a technological perspective. Meanwhile, from a pedagogical perspective, training for teachers to utilize AR effectively is essential. However, despite these challenges, with the right approach, AR has the potential to increase user engagement, deepen understandings of concepts, and enrich the learning experience. Also, with the development of technology and increasing affordability, we posit that these barriers will lessen over time.

Keywords: AR, augmented reality, learning process, medical devices

Corresponding Author: Ahmad Rieskha Harseno; email: ahmad.harseno@its.ac.id

Published: 19 November 2024

Publishing services provided by Knowledge E

Selection and Peer-review under the responsibility of the 1st ICCDBS Conference Committee.

1. Introduction

Education in the field of medicine and medical technology faces unique challenges, one of which is the need to present complex and technical information to students. In this context, Augmented Reality (AR) emerges as a potential solution that can enrich the learning process. AR technology offers a new way to present information interactively, thereby helping students understand technical concepts better. Apart from that, AR also provides an opportunity for students to practice using medical tools in a simulated environment before dealing with real situations.

In terms of the scope of application, AR can be used in the learning process for medical devices. Education in the medical realm is generally a learning process in a work environment and includes the mastery of complex abilities that require professional standard performance in a work environment. However, training in real situations is often not feasible due to considerations of safety, cost, or teaching methods [1]. Therefore, alternative methods are needed to achieve high clinical performance. The use of AR in medical education and medical technology in institutions of higher education and professional training can provide insight into how AR can be used to increase the effectiveness of learning medical devices, including how AR can be used to increase students' understanding of technical concepts and provide practical experience.

The background to this topic is the rapid evolution of AR technology and its ability to aid the learning process in the medical and health technology sectors. The main goal is to examine how the use of AR can facilitate the learning process of medical devices as well as determine what barriers may arise during its implementation.

2. Literature Review

The rapid development of AR technology and its potential to support learning in medicine and medical technology. The aim is to investigate how the application of AR can support the learning process for medical devices and identify what challenges may be faced in its application.

a. AR Applications in Medical Education

Augmented reality (AR) has the potential to improve teaching and learning in medical education, particularly in the field of human anatomy. For example, the potential use of AR and 3D models to demonstrate normal ankle and foot anatomy [2]. Integration of digital images and 3D models in a human anatomy course, emphasizing the benefits of these technologies in supporting students' understanding and knowledge acquisition [3].

b. Use of AR in Learning Medical Devices

In the context of medical devices, AR applications can be used to train students about how the device works and how to use it in specific clinical or surgical procedures. Compares traditional anatomical textbooks with an immersive VR anatomy atlas and finds that the VR group had better learning outcomes and memory retention [4]. The use

of virtual technologies in teaching anatomy highlights their effectiveness in enhancing students' anatomical learning skills [5].

c. Obstacles and Challenges

While there are many potential benefits from using AR in medical education, there are also some challenges that need to be addressed. The various uses of AR in medicine and its potential to save lives, but acknowledges that it is still in the early stages of development [6]. AR can be an effective surgical teaching and training tool for medical students, but also noted the need for further exploration of limitations such as visually-induced motion sickness [7]. The advantages of AR in education, including its ability to make the learning process more active and meaningful, but also acknowledges the need for future research to address its limitations [8].

Overall, although there are still challenges that need to be faced, Augmented Reality technology has excellent potential to help the learning process about medical devices. The wide application of AR in medical education and healthcare, emphasizing their potential to improve the quality of medical care and enhance medical education and training [9].

2.1. Hypotheses

This research hypothesizes that the use of AR can be a valuable tool in medical education, providing students with a more immersive and interactive learning experience to enhance their understanding and practice of technical concepts.

3. Methodology Research

This research methodology approach involves analyzing literature related to the application of Augmented Reality in medical education as well as conducting case studies at several educational institutions that have implemented this technology. The methodology is carried out with a benchmark review through literature studies that compare and evaluate best practices or standards in a field or industry.

a. Literature Search: Conduct a systematic search of scientific databases to locate articles, reports, conferences, and other sources relevant to the research question. AR-enabled remote simulation for critical care teaching was acceptable and enjoyable for participants, highlighting its potential value in medical education [10].

b. Data Extraction: Collecting important information from each source, AR-based programs and their impact on knowledge, practical skills, and social skills of medical students [11].

c. Analysis and Interpretation: provides a critical synthesis of current trends in AR technology and its application in medical education [12].

4. Results and Discussion

There are various ways to use AR in the medical device learning process. Some of the critical applications identified include 3D visualization of medical devices, simulation of clinical or surgical procedures, motor skills training, and distance learning [13]. Among these applications utilize currently developing technology, with functions including:

a. 3D visualization: enhancing education by allowing students to explore and understand the structure and function of medical devices through interactive 3D visualization [14].

b. Procedure Simulation: AR applications are used to simulate specific clinical or surgical procedures using virtual models of patients and medical devices. AR in medical education, with the potential to save lives by providing accurate diagnoses and effective treatments [6].

c. Motor Skills Training: use of AR to train students' motor skills in using specific medical tools.

d. Distance Learning: The benefits of increased interactivity and continuous availability of 3D learning applications [15].

There are also types of categories in the application of Augmented Reality, including:

a. Perception of the Real Physical World: AR aligns virtual objects with the real world in real-time, aiming to create the sensation that virtual objects exist in the real world [16].

b. Presence Experience: integration digital of movement, action, and situation in the real environment [17].

c. Information Comes to the User: use contextual channels to deliver information to users. These platforms provide progressively more information based on user interaction [18].

d. Multisensory Experience: Although many AR applications today primarily use visuals, this technology also has the potential to create multisensory experiences by adding sound, vibrations (haptics), and even smell or taste.

e. Merging the Real and Virtual World: An AR interface that integrates diverse virtual information into the real-world setting, facilitating interactive experiences.

In Augmented Reality, there are various types of interactions produced, including:

a. Real-time linking to content and users: AR enables real-time linking of content and users. Information and responses can be received and sent right away.

b. CAVE (Cave Automatic Virtual Environment) as representation: Augmented Reality, which can be used through a room that allows a number of users to view 360° virtual applications, thus creating an immersive and reality-like experience [19].

c. Holoportation Integration of people and objects into a real physical environment: Objects and objects are displayed holographically in the user's physical environment. Technology integrates the real world with the virtual world, thereby creating new interactions between humans and technology.

Of course, there are challenges in implementing Augmented Reality technology, especially in implementing it in the Learning Process of Medical Devices, including:

a. Compatibility: integration of AR applications with existing learning systems or use of various types of medical devices in AR simulations. Applications created for one platform may only work on another platform with substantial modification. For example, a program designed for Google Glass may only work on Microsoft HoloLens with certain adjustments or an application on Google Play that needs to be developed to work on iOS.

b. Infrastructure: hardware and software for using AR. For example, a special AR headset, a computer or mobile device with high processing capacity, a stable and fast internet connection to ensure remote presentation of 3D medical models in real-time.

c. Content Quality: To produce high-quality, accurate, and educational AR learning content requires a comprehensive workflow, careful planning, and ongoing research and evaluation.

TABLE 1: Category Application Augmented Reality.

Name	Categories	Interaction	Content
Olympus UpSurgeOn Neurosurgery	Multisensory experience	Real-time linking to content and users	Special experiences, neuro surgical training experience
Medivis	Merging the real and virtual world	Holoportation Integration of people and objects into a real physical environment	facilitates accurate planning for complex operations in the fields of neurosurgery, orthopedics, and reconstructive surgery
Orca Health	Information comes to the user	Real-time linking to content and users	Spine information
Medtronic Touch Surgery Simulator	Information comes to the user	CAVE as representation	guide to surgical and medical procedures, allowing trainees to learn procedures, test their knowledge, and rehearse for surgery.
ARtec Kochi AppeAR Biology Lab	Information comes to the user	Real-time linking to content and users	information related to the anatomy of organs in the body
Skull & Intracranial Atlas	Presence experience	Real-time linking to content and users	neuroanatomy learning
Yoga by Muscle & Motion	Information comes to the user	Real-time linking to content and users	anatomical analysis especially for muscle & motion
Anima Res Insight Lung	Multisensory experience	CAVE as representation	studying the lungs, especially about Asthma and COPD.
VOKA Pathology	Information comes to the user	Real-time linking to content and users	medically based human anatomy and pathology, including rare diseases
Philips Avent Digital Pregnancy	Presence experience	Real-time linking to content and users	care tips for mothers and so you can track your baby's development
Dental Illustrations	Information comes to the user	Real-time linking to content and users	anatomy, explanations and immersive dental care tips

Source: (Data personal)

d. User Acceptance: the existence of resistance from users (for example, students or medical staff) to the adoption of new technology for the learning process.

e. Ergonomic Issues: Prolonged use of AR devices may cause visual or physical fatigue in users.

f. Latency: Delay in system response in the learning process has a detrimental impact on the learning process experience.

g. Graphic Quality: Creating realistic and interactive 3D modeling results can be a challenge in delivering information and learning media to users.

Even though there are various challenges in developing Augmented Reality devices, there are opportunities to use Augmented Reality based on social media such as Snapchat, Facebook, Instagram, and Tiktok. Currently, in Indonesia, the applications that are on the rise as social media-based AR platforms are Instagram and TikTok. The manufacturing process does not take much time and can be learned briefly and simply. However, these challenges remain but can be minimized, especially in compatibility and infrastructure.

5. Conclusion

In the midst of rapid technological developments, Augmented Reality (AR) has proven itself to be a valuable tool in various applications, one of which is education in the health sector. In this research, there are opportunities for how AR can be used to facilitate the learning process for medical devices and find several significant benefits:

a. Learning Effectiveness: AR allows students to visualize and interact with 3D models of complex medical devices. This process can help them understand the structure, function, and operational procedures of the tool better than traditional learning methods. Thus, AR increases learning effectiveness and helps students master complex concepts.

b. Personalization: By integrating computer-generated imagery with the real world, AR technology can facilitate a rich, immersive learning experience. This allows students to engage with 3D objects and involves various sensory inputs in the course of their education.

c. Time Efficiency: This study also shows that the use of AR in the learning process can reduce the time required for students to reach a level of competency in operating medical devices compared to traditional methods. This makes the technology not only pedagogically effective but also efficient.

d. Accessibility: One of the other significant advantages of AR is its accessibility. With this technology, students in remote or underserved areas can still get quality education about medical devices even though they do not have direct access to health facilities or physical laboratories.

e. Reduced Operational Errors: The use of AR also helps reduce operational errors or failures by students when using medical devices, as it provides opportunities for simulation exercises before real practical applications.

AR can provide a more immersive learning experience for medical students, enhancing their understanding, and practical skills. AR offers a situated learning experience that supports complex medical learning and transfer. AR in medical training, such as simplifying the delivery of complex information. Overall, AR in medical education and its potential to transform the way medical devices are taught and learned.

References

[1] Kamphuis C, Barsom E, Schijven M, Christoph N. Augmented reality in medical education? Perspect Med Educ. 2014 Sep;3(4):300–11.

[2] Geerlings-Batt J, Tillett C, Gupta A, Sun Z. Enhanced visualisation of normal anatomy with potential use of augmented reality superimposed on three-dimensional printed models. Micromachines (Basel). 2022 Oct;13(10):1701.

[3] Kažoka D, Pilmane M, Edelmers E. Facilitating student understanding through incorporating digital images and 3D-printed models in a human anatomy course. Educ Sci (Basel). 2021;11(8):380.

[4] Gloy K, Weyhe P, Nerenz E, Kaluschke M, Uslar VN, Zachmann G, et al. Immersive anatomy atlas: Learning factual medical knowledge in a virtual reality environment. Anat Sci Educ. 2021. DOI: 10.1002/ase.2095

[5] Karbasi Z, Niakan Kalhori SR. Application and evaluation of virtual technologies for anatomy education to medical students: A review. Med J Islam Repub Iran. 2020 Dec;34:163.

[6] Chimakurthi VN. Efficacy of augmented reality in medical education. Malays. j. med. biol. res. 2019. DOI: 10.18034/mjmbr.v6i2.609

[7] Shah A, Kaka A, Kumar NS, Patel A, Yunus A. Effectiveness of augmented reality for surgical training of medical students: A systematic review and meta-analysis. Br J Surg. 2023. DOI: 10.1093/bjs/znad258.578

[8] Saidin N, Abd Halim ND, Yahaya N. A review of research on augmented reality in education: Advantages and Applications. 2015. DOI: 10.5539/ies.v8n13p1

[9] Hsieh MC, Lee JJ. Preliminary study of VR and AR applications in medical and healthcare education. 2018. DOI: 10.21767/2574-2825.100030

[10] George O, Foster J, Xia Z, Jacobs C. Augmented reality in medical education: A mixed methods feasibility study. Cureus. 2023 Mar;15(3):e36927.

[11] Dhar P, Rocks T, Samarasinghe RM, Stephenson G, Smith C. Augmented reality in medical education: Students' experiences and learning outcomes. Med Educ Online. 2021 Dec;26(1):1953953.

[12] Parsons D, MacCallum K. Current Perspectives on augmented reality in medical education: Applications, affordances and limitations. Adv Med Educ Pract. 2021 Jan;12:77–91.

[13] Langer E. Media innovations AR and VR: Success factors for the development of experiences. Springer; 2023. DOI: 10.1007/978-3-662-66280-9

[14] Bhatla S, Tripathi V. Augmented reality: The emerging rechnology in medical field. In [eds]. Technologies applied to electronics teaching. 2022. DOI: 10.1063/5.0106014

[15] Nicola S, Stoicu-Tivadar L. Sharing the IT educational experience of developing 3D applications for medical students training. In: International Conference on Informatics, Management and Technology in Healthcare; 2022. DOI: 10.3233/SHTI210895

[16] Barde S. Innovation of the new world; Integration of virtual object in real world mrs. Comput Sci. 2013.

[17] Carassa A, Morganti F, Tirassa M. Movement, action, and situation: Presence in virtual environments. 2004.

[18] Ajanki A, et al. An augmented reality interface to contextual information. 2010. DOI: 10.1007/s10055-010-0183-5

[19] Dörner R, et al. Virtual und augmented reality (VR/AR). Springer-Verlag; 2013. DOI: 10.1007/978-3-642-28903-3