CHALLENGES IN IMPLEMENTING VIRTUAL REALITY IN MEDICAL CURRICULA

Obianuko D. Opeyemi Adesina

I. INTRODUCTION

The history of medical education has been one rife with technological advancements. From Leonardo Da Vinci's dissection and study of cadavers, [1] to the invention of anatomical models; and even more recently, the use of the internet & digital media to study dissected bodies. Each breakthrough has helped breach a prior barrier in the field of medical education especially pertaining to anatomy. Today, virtual reality (VR) promises further insights into the study of the mechanics of the human body, offering a unique level of interaction and immersion.

However, despite the innovation that virtual reality promises, its implementation in the field of anatomy is not without its challenges. From high costs and technical barriers to institutional resistance and the need for faculty training, the pathway to adoption is blockaded by several obstacles. Identifying and gauging possible solutions to these issues is important if VR is to contribute positively towards medical education.

This article explores key challenges involved in this implementation, focusing on barriers such as cost, technological limitations, accessibility, and curriculum adaptation, while also proposing solutions for overcoming these obstacles.

II. BACKGROUND INFORMATION

Evolution of Medical Curricula and Technological Integration

The adoption of technology in medical education is not a novel event. Historically, the field of medicine has benefited significantly from the advancement of technology [2], with benefits ranging from prosthetic limbs and brain-computer interfaces to wearable health monitors and magnetic resonance imaging (MRI) systems. Science and technology are constant actors in the field of medicine, so it should come as no surprise to anyone that technology should also benefit medical education. Advances such as online education and distributed resource sharing largely owe their existence to technological leaps.

Current Limitations in Anatomy Education

Cadavers constitute the gold standard for anatomical education: they offer an unrivaled experience in the process of human examination in depths that no textbook or 3D model can currently hope to recreate. Dissection provides a realistic exposure to real-time examinations of the muscles, blood vessels, and bones, granting students a glimpse into the functionalities of actual human bodies. However, the acquisition of said cadavers is beset with numerous financial, ethical, and logistic limitations that prevent medical students from taking full advantage of them. In light of this, several technological innovations are aimed at overcoming these limitations, with VR being one of the most promising alternatives.

VR in Medical Education

Virtual Reality (VR) is the use of 3D near-eye technology and pose tracking to simulate a completely virtual environment with high levels of immersion [3]. In the field of medical education, Virtual Reality introduces an innovative approach to learning complex topics and practices such as surgical procedures, anatomical examinations, and hands-on clinical practices. With the application of VR, students can expand their current understanding of these processes through their participation in more immersive examples.

A number of VR platforms and applications have been developed to facilitate this integration process. The Anatomage table[4] is a digital dissection table that allows students to examine three-dimensional images of actual human anatomical functions in high resolution. In the same vein, the VR Human Anatomy application offers virtual cadaver experiences that allow students to dissect, organize, and manipulate virtual cadavers and, in turn, extract deeper insights into the understanding of the spatial relationships of these physical processes. Through the application of these tools, virtual reality (VR) technology exhibits the ability to advance our current understanding of anatomy and the processes behind it as it pertains to medical education and training.

III. KEY CHALLENGES IN IMPLEMENTING VR

Cost and Accessibility

Given the fact that virtual reality is a rapidly developing field with limited hardware, the cost of setting up VR systems that would account for every medical student, especially in a third-world country like Nigeria, would be crippling for most institutions with budget constraints. Public institutions, in particular, would struggle to acquire the necessary funding for implementing it at a functional scale. Also worthy of note are the regular upgrades and maintenance of both software and hardware that would be required to maintain an up-to-date contemporary system.

Technological Limitations

As advanced as modern VR systems are, they still face drawbacks and bugs that limit their level of immersion, one of which is the underdevelopment of haptic feedback [5]. This is a limitation that would pose significant problems in the process of cadaver dissection, preventing students from learning the required amounts of force and strain necessary for cutting through certain sections cleanly & delicately. Limitations like this, and the inability of VR to replicate the nasal processes necessary in medical studies raise a significant on its adoption into curriculums [6].

Lack of Faculty Training and Resistance

A considerable number of current medical educators in Nigeria are not conversant with contemporary technologies, especially concerning modern medical educational tools. The cost and time required to retrain them in the processes involved could be cumbersome for most schools. This re-education process could also foster resistance in the staff, who could raise arguments that the current traditional teaching methods are superior.

Regulatory bodies would also be slow to adjust or develop accreditation standards to accommodate VR education, increasing the difficulty of institutions adopting VR-based educational curriculums.

Student Adaptation and Learning Curve

Modern medical students are generally competent in technology, however, Virtual Reality hardware and software are new technologies that are still improving their user interfaces. This could lead to a learning curve, significantly derailing attempts at VR integration.

There are also concerns that students from poorer socioeconomic backgrounds would be able to afford or access the hardware required, leading to a gap in understanding.

Physical and Psychological Concerns

Studies have shown that extended uses of VR could lead to an increase in headaches, motion sickness, and eye strain [7][8], all of which could negatively affect the welfare of students. The inability of VR to fully eliminate these side effects could be the biggest stumbling block in its path to widespread adoption.

IV. Proposed Solutions for Overcoming These Challenges

Reducing Costs and Financial Barriers

To increase the accessibility of VR, institutions should open partnerships with technological companies to receive discounts on hardware or software. Sharing VR resources among medical departments may also reduce costs. In addition, government grants and educational funds specifically aimed at technological innovation could ease the financial burden of VR implementation.

Advancing Technology

As VR technology evolves, developers are working on building more immersive systems with better tactile feedback. Collaboration between VR developers and medical educators could result in more accurate VR applications, covering a wider range of educational needs. Nasal feedback systems, while a long way in the making, are certainly in development and could lead to more accurate VR experiences in the future. [6]

Faculty Training and Support

Constant faculty training and retraining is beneficial to any Institution. Workshops, seminars, and online courses could be leveraged to improve the capabilities of educators in the field of VR education. Promoting early adopters of VR as champions for the technology can also help reduce resistance among more traditional faculty.

Curriculum Integration and Alignment

Institutions can gradually integrate VR into the curriculum by starting with supplementary modules rather than a full overhaul of existing programs. Beginner programs that focus on specific learning outcomes can help educators assess the effectiveness of VR and make adjustments as needed. Involving accreditation bodies in discussions about incorporating VR into standards can streamline its integration into curricula. [7]

Facilitating Student Adaptation

Students can be introduced to VR gradually through orientation sessions or introductory workshops, helping them become more comfortable with the technology. Blended learning approaches that combine traditional methods with VR can ensure that students still receive the necessary hands-on experience while benefiting from the immersive aspects of VR.

Ethical and Psychological Concerns

Institutions can reduce issues like motion sickness by limiting VR session lengths or enforcing breaks during lessons. In the meantime, developers should work to reduce the side effects of VR immersion or eliminate them entirely.
[7,8]

V. CASE STUDIES

Case Study 1: VR as Effective as Traditional Learning Methods

A 2017 study[7] assessed the effectiveness of virtual reality (VR) and augmented reality (AR) in teaching anatomy compared to tablet-based (TB) applications. The research involved 59 participants randomly allocated to one of the three modes of learning, focusing on skull anatomy. Results showed no significant differences in mean assessment scores across VR, AR, and TB modes. However, VR participants reported more frequent adverse effects like headaches, dizziness, and blurred vision.

Case Study 2: Reducing Visual Discomfort in VR

A clinical trial published in 2015[8] explored the visual discomfort experienced by users of head-mounted displays (HMDs) during VR sessions. The study investigated the effectiveness of dynamic depth-of-field (DoF) blur to alleviate symptoms such as eye fatigue, headaches, and nausea. Using a commercial game engine implementation, participants reported reduced discomfort when DoF blurring was enabled. The study demonstrated that dynamic DoF could effectively minimize visual discomfort, improving the user experience in VR-based educational environments.

VI. Discussion and Conclusion

VR integration in medical education promises effective transformation potential, especially in the field of anatomy. However, the challenges it faces such as high costs, tactile feedback, and institutional resistance can slow down its adoption. As the technology becomes more affordable and the hardware more accessible, it has the potential to expand and become more accepted by institutions everywhere, particularly those without good access to cadavers.
With research ongoing to improve the rate of realism and reduce the rate of side effects on the user; along with investments from several organizations and medical institutions, VR could very well become the new gold standard in the world of anatomy and medical education.

REFERENCES

1. Jones R. Leonardo da Vinci: anatomist. Br J Gen Pract. 2012 Jun;62(599):319. doi: 10.3399/bjgp12X649241. PMCID: PMC3361109. PMID: 22687222.

2. Bajwa M. Emerging: 21st-century medical technologies. Pak J Med Sci. 2014 May-Jun;30(3):649-655. doi: 10.12669/pjms.303.5211. PMCID: PMC4048524. PMID: 24948997.

3. Virtual reality. In: Wikipedia [Internet]. Available from: https://en.wikipedia.org/wiki/Virtual_reality

4. Kavvadia EM, Katsoula I, Angelis S, Filippou D. The Anatomage Table: a promising alternative in anatomy education. Cureus. 2023 Aug;15(8):e43047. doi: 10.7759/cureus.43047. PMCID: PMC10484354. PMID: 37692592.

5. Våpenstad C, Hofstad EF, Bø LE, Langø T, et al. Limitations of haptic feedback devices on construct validity of the LapSim® virtual reality simulator. Surg Endosc. 2012 Dec;27(4). doi: 10.1007/s00464-012-2621-9.

6. Andonova V, Reinoso-Carvalho F, Jimenez Ramirez MA, Carrasquilla D. Does multisensory stimulation with virtual reality (VR) and smell improve learning? An educational experience in recall and creativity. Front Psychol. 2023;14:1176697.doi:10.3389/fpsyg.2023.1176697.PMCID: PMC10308939. PMID: 37397289.

7. Moro C, Štromberga Z, Raikos A, Stirling A. The effectiveness of virtual and augmented reality in health sciences and medical anatomy. Anat Sci Educ. 2017;10(6):549-559.

8. Carnegie K, Rhee T. Reducing visual discomfort with HMDs using dynamic depth of field. IEEE Comput Graph Appl. 2015 Sep-Oct;35(5):34-41. doi: 10.1109/MCG.2015.98.