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Limitations of Visualization Technology and Virtual Instruction in Medical Education

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Introduction

Traditional medical education has recently seen major changes due to the coronavirus (COVID-19) pandemic. New pedagogical methods, including augmented reality (AR) and virtual reality (VR), are on the rise as alternatives to traditional teaching methods. While AR enhances real world experiences by overlaying information, VR immerses users in a computerized world rather than enhancing reality. It is crucial to understand the limitations of these learning modalities and that at best these modalities should be used to supplement and not replace traditional medical education.

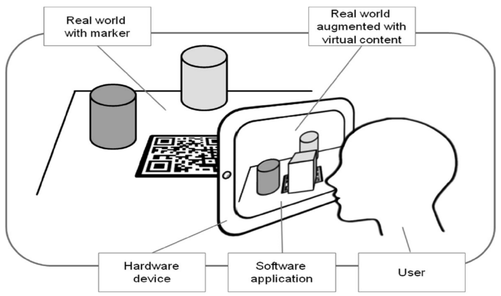

Fig. 1 Virtual content (*block*) is added to the real world (*table*). A hardware device (*tablet*) including software is used to make the content visible for the user

Professional and Interpersonal Skill Development

Traditional teaching provides students with early exposure to their first patient in the anatomy lab. Donors, like patients, surrender their bodies to future doctors to be handled with care and professionalism. Student doctors develop empathy and respect for donors under the guidance of experienced faculty and academics. Instructor-led discussions permit students to express their personal views on inevitable topics like mortality and grief. This prepares students for future difficult patient situations and enables them to develop coping skills.

Problem-Solving Skills

In a study where arm cadaver models were used to implant nerve fascicle electrodes, it was concluded that having this microsurgery conducted on cadaver models before patients is necessary especially for the development of operating protocols to be established before practicing this high-risk methodology on nerve structures with great anatomical variability.

Physician-Patient Relationship

Physical interaction cannot be properly replicated within the confines of a VR or AR learning experience. In current medical education models students are taught a "voiceless dialogue", which includes the way the physician approaches, touches, and deals with the patient, making the patient feel whole, respected and integrated; a satisfying and rewarding feeling that can have positive mental outcomes. Touch has limbic connections to past experiences, meanings, and emotions and therefore allows a dynamic assessment of one of the major osteopathic practice models, the biopsychosocial model.

Financial Challenges

In a study published in 2019, Farra et al compared costs of a VR simulation and hands-on training for an evacuation training event for nurses. It estimated the total cost for the development and VR training simulation for 34 nurses to be $106,951.14. Of that cost nearly $80,000 was for the development of the virtual simulation. If this form of education is adopted in medical programs, they will need to develop many unique training simulations, which will rapidly drive up the implementation costs for this educational approach.

Table 1. Live Exercise Costs

Item	Personnel	Cost[a]	Total
Exercise planning	16 Staff	$44.90 per meeting hour × 160 h	$7184.10
Exercise participants	57 Staff	$31.89 per participant hour × 85.5 h	$2726.42
Exercise support	5 Staff	$41.68 per support staff hour × 120.5 h	$5021.88
Exercise evaluation	6 Evaluators	$42.36 per evaluator hour × 87 h	$3685.14
Room charge[b]			$0.00
Total			$18 617.54

[a]Salaries were direct costs (do not include fringe costs).

[b]No costs were incurred to host the mannequins in a patient room; this may not be true at other facilities or under different circumstances and should be considered.

Technological Limitations

One challenge for VR headsets is to reduce the latency of the video rendering time, which if is greater than 15 ms, can cause a sensory mismatch leading to cybersickness. Also, wireless headsets struggle to present the video quality that would be integral to a realistic virtual learning environment.

Conclusion

Virtual and augmented reality are rapidly being adopted in many academic fields, and while it is almost inevitable that these will be used in medical programs, it is important to understand the limitations that these learning modalities pose. VR and AR learning environments can be incredibly fruitful, but in their still-nascent state these technologies are best used as a supplementation to tried-and-true educational approaches rather than a replacement.

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Hi, I am Josh kocemba and I will discuss the financial and technological challenges of VR and AR implementation in medical education

Financial

The costs for developing the software and acquiring the equipment can accumulate rapidly. A recent study calculated the cost for developing one training exercise, totalled nearly $107,000. It is important to note that medical programs would have many of these simulations, each with their own cost. It is likely that these new financial burdens would be passed on to the students.

Technology

A major hurdle for bringing VR into the medical classroom is the limitation of making it feel like a real experience. Most of the current model VR headsets are wired, which tethers the user to a computer. These allow for high-fidelity audio and visual input, however wireless headsets, which would be better suited for creating an environment free of tripping hazards, and thus a more immersive experience, cannot achieve the high quality of video, compared to the wired counterpart. Slow latency limits the user experience, and can lead to motion sickness, which is commonly called cyber sickness.

]Conclusion

Virtual and augmented reality are rapidly being adopted in many academic fields, and while it is almost inevitable that these will be used in medical programs, it is important to understand the limitations that these learning modalities pose. VR and AR learning environments can be incredibly fruitful, but in their still-nascent state these technologies are best used as a supplementation to tried-and-true educational approaches rather than a replacement.

Visuohaptic Training

Visuohaptic training promotes statistically significant better recall results than either visual or haptic training alone. Current AR/VR haptic simulation has not proven to adequately replace anatomy lab haptic experience. Vishy Mahadevan, professor of anatomy at the Royal College of Surgeons, notes an increasing number of surgeons with lack of confidence. He attributes this to an inadequate understating of anatomy. Current VR/AR anatomical simulations may not be ready to foster an appreciation in this subject which can carry heavy downstream costs.