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Advances in Virtual and Augmented Reality—Exploring the Role in Health-care Education

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A B S T R A C T

Recent years have seen an increase in the use of virtual and augmented reality platforms for health-care education. These have been used for teaching anatomy, simulation of emergencies, and procedural training. We review the potential roles and ongoing challenges related to implementation of this technology.

Overview

The last 5 years has seen a tremendous increase in the availability and use of virtual reality (VR) and augmented reality (AR) hardware. These devices typically take the form of headsets that can be used to either block out external visual stimuli (VR) or overlay graphics on a real-world environment (AR). In addition, this technology is now available on smartphones (Figure 1).

In 2018, it was estimated that some 12.4 million headsets were shipped worldwide, with this number forecast to increase to 68.9 million in 2022 (AR/VR headset hardware). An important potential use for the technology is to assist with learning new skills. Health-care workers have embraced the technology by using it in a variety of areas, including surgical training (Seymour et al., 2002), preoperative planning (Juhnke et al., 2018), and intraoperative navigation assistance (van Oosterom et al., 2018). In the case of clinical use, where visualization of the actual room or procedure is important, users are best served by an AR system.

Beyond the operating room setting, the technology has also been used for health-care training and simulation. VR platforms for various surgical procedures have been available for many years now (Pelargos et al., 2017; Thomsen et al., 2017) and have shown to improve technical performance of surgical procedures (Nagendran et al., 2013). The technology has also been used in the interventional radiology setting, where procedures and simulated emergencies have been recorded and displayed in a VR headset (McCarthy et al., 2018).

Patient engagement

Health-care professionals have, by virtue of their experience, a comprehensive understanding of the anatomy, pathology, and technical factors involved in invasive procedures. Conversely, many patients facing illness may have a limited understanding of their condition. VR and AR have the potential to offer patients a novel way to explore their medical condition. For example, one group of researchers has developed a tool that allows pediatric patients to view a personalized, VR tour of their own endoscopy (Fliesler, 2018). Incorporating the technology into patient education offers the potential to increase patient engagement and overall satisfaction with their medical care.

Application in nursing education

An example of AR that many practitioners are already familiar is the infrared device that assists with vein localization, whereby the location of the veins is displayed on the patient using a projection-based AR system. A VR or AR learning environment can supplement existing resources including textbooks, online resources, and inservice reviews. A 3D learning environment has been shown to increase learner engagement and improve the contextualization of learning (Dalgarno and Lee, 2009; Pelargos et al., 2017).

Many health-care professionals are familiar with simulation-based training, whether this is for cardiopulmonary resuscitation training or other medical emergencies, such as a contrast reaction (Niell et al., 2015). A benefit of using VR equipment for the delivery of medical simulation content is that such content can be reviewed at a time convenient to the learner, thereby decreasing the effort, coordination, resources, and expense associated with hands-on simulation training (Chang and Weiner, 2016).

The benefits of being able to overlay internal anatomy during a procedural task were highlighted in a recent article by Aebersold et al.

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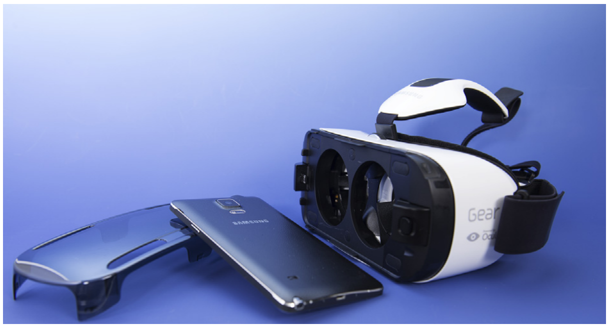

Figure 1. Modern smartphones now have sufficient processing power to allow for virtual and augmented reality content to be displayed. Some phones, such as that pictured here, are compatible with lightweight head-mounted displays, allowing for an immersive experience that includes the ability to track head position and movement.

(Aebersold et al., 2018). In this study, 69 nursing students were observed during placement of a nasogastric (NG) tube in a mannequin. Approximately half of the participants used a tablet-based AR overlay to assist with NG tube placement. Those students with access to the AR module reported increased satisfaction with the training compared with the control group. In addition, students using the AR trainer showed improved competency at NG tube placement in a model compared with those with access only to a video and didactic training.

With the assistance of a Department of Labor grant, the Augmented Reality Integrated Simulation Education (ARISE) project has set out to develop over one hundred health-care scenarios that will be made available on an open-source basis. Using a combination of game-based situated learning theory (Brown et al., 1988), simulation, and AR, the platform has shown promise; preliminary data have shown initial acceptance of the technology among participants (Carlson and Gagnon, 2016).

There are some existing options for developing a customized VR simulation program. One of the more commonly used platforms, Second Life, allows for the creation of a virtual world where students can explore simulated learning experiences that prepare them for clinical practice (Caylor et al., 2015). As the hardware that supports VR and AR becomes more widely available, these virtual worlds may provide a robust environment for education and interdisciplinary simulation (Boulos et al., 2007).

When students make the transition from classroom to hospital or clinic, the vast array of various medical devices can be overwhelming. Garrett et al. (Garrett et al., 2018) outline a program that involved nursing, occupational therapy, and physical therapy students. Over 100 items, ranging from chest tubes to ceiling lifts and syringes to infection control posters, were identified by instructors for incorporation into the AR program. These items were tagged using decals or quick response codes, and scanning the code provided users with access to AR educational materials.

Although VR and AR are engaging and novel modalities, they are still viewed as experimental by many (Garrett et al., 2018). Nonetheless, it has been shown that knowledge acquisition and self-directed learning improves for nursing students in a skills laboratory setting when AR is used (Garrett et al., 2015). Ongoing collaborations between health-care providers and technology industry will hopefully allow this technology to flourish (Case western reserve).

Despite advances, there is still considerable work required to bring VR and AR to mainstream health-care education. The costs associated with initial technology purchase remain high, relative to the price of textbooks and online resources. In addition, development of high-quality content requires a degree of technical knowledge that is beyond what an average technology user possesses. At the time of writing this article, there are very few “off-the-shelf” options of educational content. Finally, there are ergonomic limitations associated with the use of head-mounted displays, including neck pain with prolonged use and the potential for nausea and vertigo related to issues surrounding latency. It is likely that these issues will continue to be addressed as the technology improves.

It is clear that there is considerable interest in using VR and AR in health-care education; however, significant challenges remain. In the future, decreasing device costs, improved form factors, and improved access to virtual and augmented educational tools may allow for increased incorporation of such interactive content into health-care learning curricula.

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