NEW IDEAS

# Learner-Centered Operating Room Training Using Augmented Reality in 2030

## Setting and Problem

Simulation-based learning is critical for competency development in medical residents. During the last decade, head-mounted virtual reality (VR) systems have improved their photorealism, processing speed, and ability to capture benchmark performance. VR simulation-based training systems have effectively replaced expensive mannequins in simulation centers, enabling learner-centered medical training accessible even at home. Recent studies demonstrated comparable outcomes on most learning objectives for VR simulations when compared to mannequin-based training. Most residency programs now require specific VR scenarios each year to demonstrate accomplishment of educational benchmarks. These VR systems provide real-time tracking and immediate visual feedback to learners. However, supporting multiple roles in a training scenario and realistic haptic feedback are 2 areas where VR-based medical training has not lived up to expectations. Two recent technology advances are poised to make a big impact in simulation-based education. Holographic learning (HL) systems enabled by advances in augmented reality technology allow a wider field of view and realistic overlay of computer-generated imagery over real world objects. Innovative 3-dimensional (3D) printing technology can print anatomical models with accurate material properties of various tissues. These 2 advances taken together have the potential to overcome limitations of VR-based medical training. At the start of 2030, individual HL systems cost less than $500. Due to the affordability and improved performance of HL systems and 3D printers, they are now a potential alternative to VR for learner-centered medical education. We developed and tested operating room scenarios in a home-use HL system to allow an anesthesiologist and surgeon to work together to address the same critical medical event.

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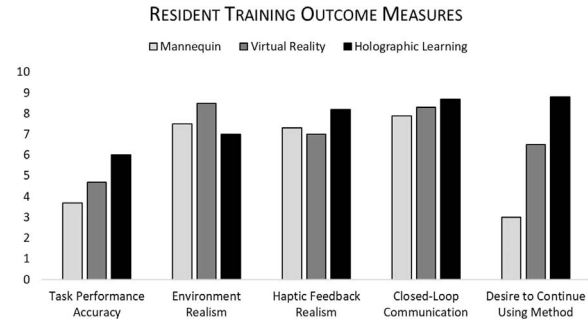


**FIGURE**
Resident Training Outcome Measures

## Intervention

In 2029, 120 new residents from anesthesiology and surgery participated in a controlled experiment comparing HL with a 3D printed anatomical model (innovative), VR-based (current) training systems, and mannequin-based (legacy) medical training systems. The study received local Institutional Review Board approval, and sample size was based on power analysis assuming large effect sizes. All participants provided informed consent. We ensured that participants had limited prior exposure to HL training systems to avoid exposure effects, and we randomly assigned them to 1 of the 3 experimental conditions. In each of the training conditions, they completed 2 emergency scenarios: a massive blood loss event and an endotracheal intubation (ETI). Both scenarios were validated in pilot studies. Subjects were required to commit to 30 minutes of uninterrupted time for simulation to ensure appropriate testing conditions. For consistency, participants in all 3 conditions used 3D printed medical toolkits including a laryngoscope with positional tracking markers to capture movement. We measured performance of participants using a series of objective measures (task time, accuracy, number of corrections of hand position during procedure, overall narrowness or wideness of procedure arcs, and accurate closed-loop communication), and gathered subjective user feedback (participant's sense of environment realism, perceived realism of haptic feedback, and acceptability of use).

## Outcomes to Date

Preliminary results indicate augmented reality HL systems are a more effective, yet affordable, alternative to both VR-based and mannequin-based simulation training (FIGURE). HL systems showed better performance in terms of response times and task performance accuracy compared to the other 2 conditions. The ratings of environment realism were slightly higher with headset VR compared to the HL

system. However, the HL system reported higher ratings for haptic feedback. Results also show that task performance for ETI was better in the HL system compared to VR and mannequin-based systems. We present our initial results to substantiate an open challenge to all fields of medicine to consider applications of home-use multiplayer HL as an option to facilitate safe, cost-effective, learner-centered medical education in 2030.

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NEW IDEAS

# A Department Wellness Initiative for Coping With Climate Distress in 2030

## Setting and Problem

Climate grief is a well-documented phenomenon, and as we embark on academic year 2030, we note that it has been an increasing contributor to resident burnout. Efforts on resident wellness in the 2020s focused on traditional concerns such as work-life balance and salary/vacation with trainee unions. Few have been prepared for the impact that the ongoing climate crisis has had on our medical trainees. Given certain social and political unrest in the coming decades, developing a cadre of highly resilient, creative, and solution-oriented women's health providers is more important than ever.

At the University of Washington (UW), rising sea levels and climate refugees from the drought-ridden Southwest and California have resulted in affordable housing shortages for our trainees. Threats to low-lying neighborhoods have led to an increase in residents living in questionably legal "floating dormitories" along Lake Washington. Forest fires in British Columbia and Oregon have led to worsening air quality in the picturesque Pacific Northwest. Regional warming and less cloud cover have resulted in sunnier days but threaten the rainforests on the peninsula. There is tension between medical students, trainees, and faculty about individual climate footprints, arguments about food waste and recycling at the end of grand rounds, and public shaming on who drove to work that day. The gynecologic oncology rotation has been particularly distressing for residents given the shortages in intravenous (IV) narcotics due to another hurricane in Houston, a key production region for IV medications. The VRE epidural crisis has been disruptive to clinical services on labor and delivery, affecting patient and provider morale.

## Intervention

A concentrated effort was enacted within our department to combat climate grief and allow us to continue our mission of improving women's health in our region and globally. A faculty member and chief resident are appointed annually to be "Climate Lead." In academic year (AY) 2030, our climate leads initiated small meaningful steps focused on achievable goals to help the department and our greater academic community deal with paralysis and fear. Each Wednesday, we recite a modified, secular Serenity Prayer during morbidity and mortality conferences to remind ourselves that acceptance is key and we cannot change everything. Given the existential threat, our department chair approved protected academic time (0.1 FTE) to interested faculty and residents for climate advocacy and community outreach. Our traditional department "Ski Day" has been transformed into an annual department hike to the backcountry, given the reduction in snowpack. Resident call room light therapy lamps

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