

VIRTUAL REALITY, REAL EMERGENCY

Integrating AR/VR in Computing and
Medical Crisis Management



EDITED BY

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Virtual Reality, Real Emergency

In an effort to investigate the revolutionary potential of augmented reality (AR) and virtual reality (VR) technologies in the field of mechanical and medical emergency management, *Virtual Reality, Real Emergency* was written. This book seeks to educate readers on how AR and VR may transform response to emergencies, boost training, and facilitate better decision-making under pressure. It aims to equip professionals and hobbyists alike to use these immersive technologies for saving lives and minimizing calamities by analyzing real-world applications, cutting-edge breakthroughs, and practical insights.

The ground-breaking book *Virtual Reality, Real Emergency: Integrating AR/VR in Computing and Medical Crisis Management* has two goals: to teach and to give readers agency in times of crisis. Our goal is to educate both industry experts and casual observers on the revolutionary possibilities of AR and VR in the high-stakes arenas of mechanical and medical emergency response. The gap between theory and practice is something we want to close by providing real-world insights, practical counsel, and examples of achievement. Our goal is to educate the public on the potential life-saving benefits of AR and VR technology, demystify these tools for the general reader, and provide concrete measures for incorporating them into existing emergency response procedures.

This book not only celebrates the technological advances that have been accomplished but also calls for more cooperation to ensure that these innovations are implemented in a way that puts people's lives first during emergencies.



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The Effect of Virtual Reality Instructors on the Development of Surgical Competence

Thulasi Bikku, K. Suresh Kumar, M. Clement Joe Anand, and Kiran Sree Pokkuluri

1.1 INTRODUCTION

Investing time, money, and specialized supervision into training surgeons is no small feat [1]. Surgical illness burdens are significant in many low- and middle- income countries, yet postgraduate surgical training opportunities are few [2–4]. Surgical training materials may be shared with large, geographically distributed audiences via the use of inexpensive and scalable virtual reality (VR) technology [5]. These include:

- Faculty of specialist surgeons teaching surgical techniques using cadaveric specimens.
- Participants engaged in in-person, practical instruction.
- Content captured with 360-degree video and several stationary camera perspectives.
- Live-streamed content is to distant representatives in a 360-degree perspective [6], with overlays from fixed cameras to provide various views.

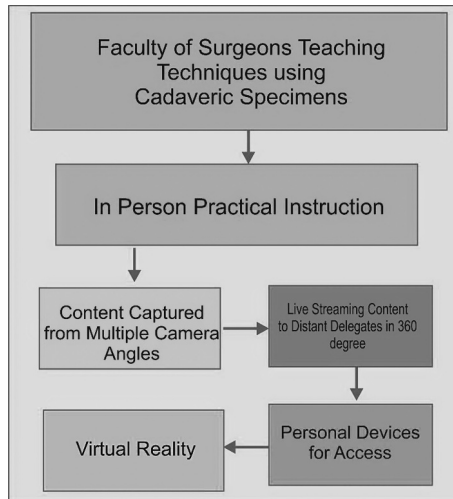


FIGURE 1.1 Virtual reality technology materials.

- Virtual reality headsets with high specifications [7], smartphones with low-cost VR headsets, or smartphones alone are all examples of personal devices that can access VR-content laptops only (360-degree video) [8] (Figure 1.1).

VRiMS first offered five courses designed to meet the requirements of surgical trainees and subsequently modified those courses to meet the demands of surgical training in low- and middle-income countries [9–11]. By utilizing a mixed-method assessment, we provide the results of the first Global VRiMS course [12], which was jointly organized by academic and clinical groups.

1.2 METHODOLOGY

1.2.1 Initial Investigation

A suggested one-day preliminary inquiry included “Bellwether” measures that might save lives. Faculty members imparted knowledge both in-person and online [13]. Nearly thirty-six low- and middle-income countries (LMICs) and seventeen high-income countries (HICs) sent representatives to the free, worldwide live stream. Users were actively

involved (with a mean engagement time of over 140 minutes per delegate) [14], however feedback after the course was seldom used.

1.2.2 Creation of Content

Surgical, obstetric, and trauma-related procedures from the World Health Organization's "Essential Surgery Package" served as the basis for the development of the individualized course material via GASOC's (the Global Anaesthesia, Surgery and Obstetrics Collaborative) vast surgical network, which the researchers were able to modify via discussions with rural/remote general practitioners, trainees, and expert surgeons [15–17]. Acquiring 360-degree video while positioned at the operation table allowed for the creation of VR material. Also, regular cameras placed at various positions allowed for simultaneous recording, which allowed for the overlay of many viewpoints [18].

As a result, the live stream showed the whole operating room as a 360-degree panorama, with several typical secure interpretations superimposed as quadrilateral figures in an edging sight [19], as if they were displayed around the table (Figure 1.2).



FIGURE 1.2 Operating room as a 360-degree panorama.

1.2.3 Recruiting Delegates

All delegates were required to pre-register, and there were no fees for the courses. Promotions reached students and medical professionals via word-of-mouth, national television, online platforms, and based on interest email lists [20–22]. Information was shared. Three-course delegations were recruited:

- Saving Faces provided an in-person, practical cadaveric training, with scholarships available to assist with expenses, including accommodation [23]. The criteria required to assess eligibility included involvement in medical practice in a low- or middle-income nation, a personal statement, curriculum vitae, surgical logbook, specialized reference letter, and a valid passport [24]. To maximize effect, emphasis was placed on candidates serving extensive, distant, or rural populations, as well as those educating other healthcare professionals.
- Daily in-person virtual training for up to 30 people, smartphone, charger, and headphones; inexpensive wooden VR headsets were provided.
- Virtual training with remote access. Anyone in the world with an internet connection, a 360-degree virtual reality headset, a smartphone [25], and a laptop may participate remotely.

1.3 EVALUATION OF RESULTS SURVEY

During registration, demographic data was gathered. Using Google Forms for both the “pre-course” and “post-course” questionnaires, they were able to gather both quantitative and qualitative data. Among the topics covered were virtual reality’s effects on course attendance, accessibility, and possible use in local clinical practice. At the beginning and conclusion of each day, questionnaires were handed out to delegates who were physically present, based on the findings from the pilots that indicated challenges with engaging with post-course feedback. Owing to their significant face-to-face interactions with the research team, this group was anticipated to respond later.

1.4 INFORMAL INTERVIEWS

Fourteen comprehensive semi-structured interviews were used to gather qualitative data. On the last day of the course, all delegates who were physically present were questioned face to face; meanwhile, delegates who were remotely present were interviewed digitally after the course had ended (April–July 2022). Participants in the interviews were given information

sheets outlining the goals and parameters of the study, and they were also asked to sign a permission document. Data were analyzed thematically using NVivo after following topic guidance and recording and transcribing interviews word for word. The research was iterative; theoretical considerations and inductive coding led to the development of themes. The dissection lab in the anatomy lab has a Public Display Licence and an HTA Anatomy Licence, which are issued by the Human Tissue Authority (HTA) and are according to The Human Tissue Act 2004.

1.5 RESULTS

Every number is rounded to the nearest tenth of a percent, and all means are given.

1.5.1 Overview of Training Programme

According to the World Health Organization and suggestions from physicians and surgeons, the course content is shown in Table 1.1. After a quick ten-minute talk covering most of the material, delegates worked with real-life examples and cadavers. In cases when the use of real cadavers is neither feasible nor ethical, such as in the case of an obstetric emergency affecting the uterus of a pregnant woman, the Limbs and Things manikins are used as an alternative. Every detail on the program is available online.

TABLE 1.1 Course Content

Title	Delivery Methods	Time Allocated
Essential surgical care access	L	42 Mins.
Trauma epidemiology and management	L	42 Mins.
Save and stabilize: airway	L, C, M	1 Hr. 30 Mins.
Stabilization: breathing, circulation, and vascular access	L, C	3 Hrs. 30 Mins.
Management of wounds and burns	L, C	2 Hrs.
Abdominal trauma management	L, C	2 Hrs.
Emergency and essential abdominal surgery	L, C	3 Hrs. 30 Mins.
The fracture management principles	L, C	2 Hrs.
Limb trauma management	L, C	2 Hrs.
Head trauma management	L, C	3 Hrs. 30 Mins.
Pregnancy complications management	L, C, M	2 Hrs.
Obstetrics/gynaecology emergencies and postpartum haemorrhage	L, C	3 Hrs.

Note: Time and delivery methods discussed throughout the training.

C–Cadaveric procedural demonstrations, L–lecture, and M–manikin demonstrations.

1.5.2 Access Method

Aside from their allotted fifteen minutes for virtual reality, in-person delegates opted for “hands-on” instruction throughout every experiential session. Delegates favoured using inexpensive cardboard headsets in conjunction with their cell phones, spaced out with brief intervals of utilizing the device/computer alone. Due to their immense popularity, the two Oculus headsets were used continuously during the whole course day. One drawback that was noted was the need to periodically charge them. The situation was different with cell phones, however, since they could still be charged while in use.

1.5.3 Demographics of Delegates

Virtual reality was used by delegates with little to no expertise, with just a small number having played games or engaged in other unnamed VR-related activities. There was a disparity between the number of attendees registered on the digital platform and the number of feedback forms completed by distant delegates. This is consistent with the observation that some group members submitted feedback forms from different devices. The post-course feedback did not specifically address this use type as it was not expected. However, the numbers show that most people logged in using only one device. People from many different countries made up the remote group’s geographically dispersed workforce.

1.5.4 Information Gathered from Surveys

High participation was reported in the survey for all three-course delegate types: remote or virtual training, in-person hands-on training, and in-person training with VR live-streaming. Even months after the course, those who had hands-on training in person still felt its influence on their clinical practice. Several delegates claimed to apply what they learned daily, and every single delegate did so at least once a month. The majority of delegates said that each delivery mode had a favourable influence on their clinical practice. This was especially true for practical sessions, lectures, and virtual reality learning.

Regarding implementation, delegates from all methodologies saw an uptick in the quality of their patient evaluations and surgical operations. Moreover, without exception, every single participant said they had taught others, and many of them said they do it often. People who watched the live stream shared their thoughts on how easy it was to access the virtual

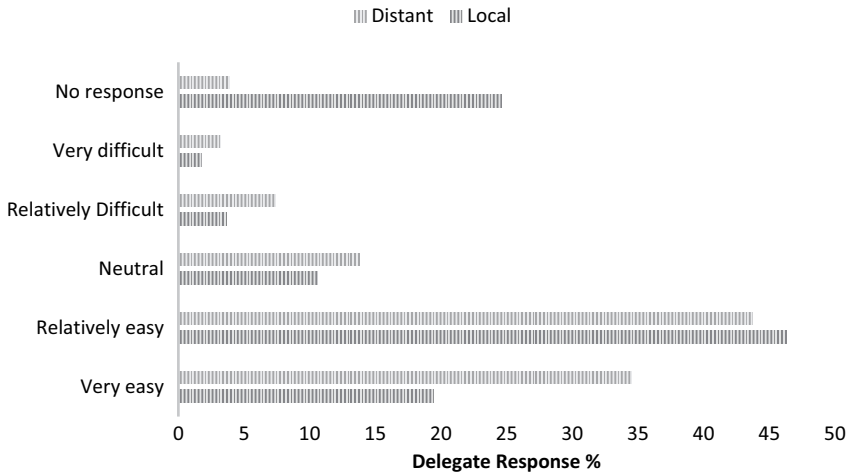


FIGURE 1.3 VR ease of use post-course survey replies from live stream delegates.

reality information, how it increased attendance, and how it might be used for local surgical education and practice. The most significant obstacle to access, as revealed in the survey’s free-form parts, was an inadequate internet connection.

Figures 1.3 and 1.4 show the replies from delegates who were either local or distant viewers of the live stream. The majority of participants said that accessing VR information was straightforward or somewhat easy;

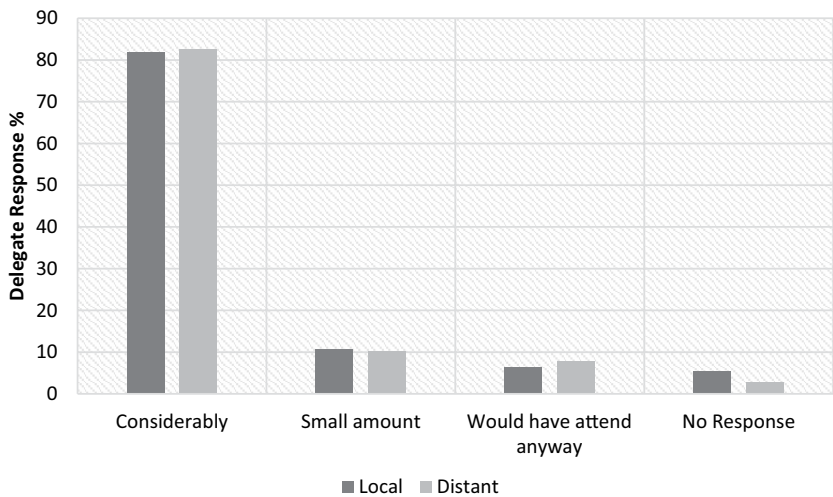


FIGURE 1.4 Post-course survey results from delegates who attended the course via live stream about VR’s appeal.

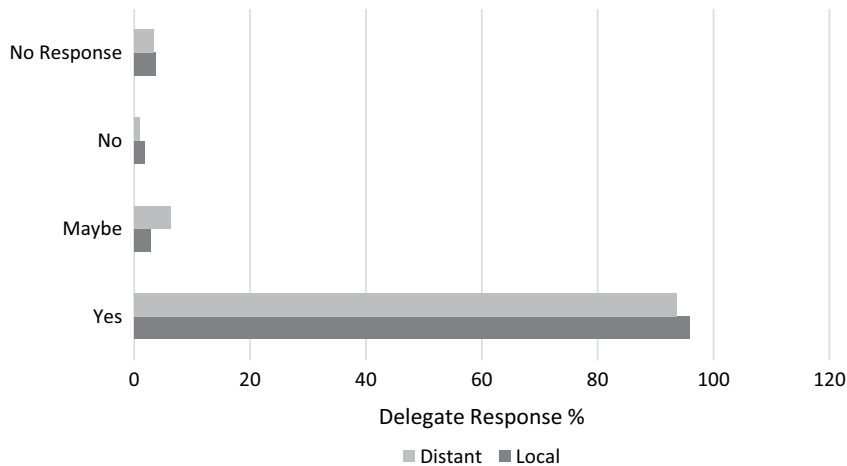


FIGURE 1.5 Live stream delegates’ post-course survey replies on VR’s usefulness.

that the virtual reality component of the sequence encouraged them to attend; and that they believe virtual reality may be useful in local surgical education, training, and practice (Figure 1.5).

1.5.5 Semi-Formal Interviews

Based on the participant interviews, three main themes emerged: first, the study’s background regarding the problem of medical training and ability development; second, how VR could assist with this via its 360-degree visualization and integrated knowing-as-seeing mechanism; and third, the persistent problems regarding the accessibility and acceptability of VR in surgical education. Notably, interviews were conducted in English, and although participants were expected to be proficient in the language, most did not speak it as their first language.

1.5.6 Training for Healthcare Professionals

Many interviewees said they do surgical operations using just what they learned in their bachelor’s degree programs since there are so few options for postgraduate training in their own countries. Medical institutions may not always back their graduates’ efforts to further their careers once they graduate. When people are responsible for paying for their education, they may feel less incentive to keep their skills current and may even be less

motivated to do so. A participant said that they sometimes use what they learned in undergrad to do little surgeries. Another brought up the difficulty of obtaining the necessary continuing professional development (CPD) points to renew a license, as going to seminars and other forms of training may be rather expensive. People who can't afford these costs will have a hard time meeting their CPD obligations.

Reports of other difficulties in the delivery of clinical education include medical students' unwillingness to consult with patients, operating room congestion that endangers patients, and the prioritizing of private consultations for financial gain over instruction. Consequently, at graduation, doctors lack extensive hands-on experience with procedures. One possible way to fill these gaps may be by offering virtual reality training options. Patients in some areas were previously more willing to participate in educational roles.

However, many patients choose not to participate right away, which has raised concerns that medical graduates may not receive the same amount of hands-on experience due to increased reading levels. Virtual reality and other emerging technologies may be the key to closing this gap. Training scenarios that emphasize the quantity of procedures over the quality of information can promote less-than-ideal operating practices and lower overall training standards. The issue is exacerbated when competent individuals lack opportunities for postgraduate education or mentorship, potentially perpetuating ineffective methods and unprovoked errors. The members were concerned that if the instruction was not sufficiently clear, the public might mishandle their responsibilities, leading to ineffective practices or errors.

1.5.7 Realizing via Seeing: 360-Degree Visualization

This portion considers the potential benefits of using 360-degree standard television technology in surgical instruction and preparation. It highlights the advantages of this technology, including a dynamic and comprehensive view, increased engagement, improved accessibility, and effective comparisons between 360-degree videos and demonstrative imaging. Orthopaedic trainees have stressed the pertinence of 360-degree videos for improving procedural accuracy and have demonstrated their potential for knowledge building by sharing insights with peers.

However, there are disadvantages to ocular education alone, such as a need for hands-on training in performing complex procedures like laparotomies. Even the most precise visual models can overlook key details when compared to physical sketches. Despite these drawbacks, 360-degree standard videos are effective when used in conjunction with hands-on training as part of comprehensive surgical education.

The summary layout may include further information. Ensuring that healthcare professionals are executing their duties correctly is critically important, as mistakes made during training can lead to serious consequences throughout their careers. As an example, a physician performing complex procedures like tracheostomies needs a reliable way to develop their surgical judgement. One doctor observed that they could leverage their expertise with intubation, for instance. Medical experts in LMICs, who do not often handle these procedures, might find this very constructive. To assist physicians in regaining confidence and accuracy when performing new procedures, the idea of a library of convenient, video-recorded clinical techniques was developed. This information repository ensures that professionals are informed and prepared for all eventualities by encompassing the latest best practices.

1.5.8 Acceptability and Ease of Access

VR for medical instruction is not yet widely feasible in depressed- and middle-income countries, according to the study's participants. The most significant concern was the price, especially for the essentials like mobile phones and VR headsets, in addition to the need for a constant internet connection. Another major challenge was the unreliability of internet access, which was especially severe in remote locations. VR participants cited high data costs and frequent connectivity disruptions as significant challenges to VR training. Users stated pain and fatigue from continuous computer simulation usage, making necessary frequent breaks, despite the technology's ease of setup.

In contrast to the awkward and intermittent scheduling of conventional dispassionate lectures, participants also highlight that VR-enhanced training may advance public engagement, continuous learning, and networking for professional or personal gain. Concerns were raised about generational resistance, particularly among older physicians who may be hesitant to adopt new technologies. Younger doctors, however, mostly favoured virtual reality as a means to remain abreast of developments in their area and to facilitate ongoing education, irrespective of their location or time constraints.

1.6 DISCUSSION

Results from the mixed-methods research show that increasing global well-being with appropriate VR material for surgical instruction requires collaborative support networks between high-income countries (HICs) and LMICs. The study underscores a significant need for VR-based simulation in postgraduate surgical instruction across a range of educational and economic settings.

VR was a major attraction at the conference, even for those who were previously unfamiliar with the technology. Surveys taken after VR courses validated the technology's ease of use and suggested ways to incorporate it into existing medical curricula. Inadequate training programs owing to scarce resources, inconsistent training structures, and a lack of access to cutting-edge technology are just a few of the problems highlighted in the interviews as obstacles to clinical training in East Africa. Virtual reality can alleviate some of these problems. The real-world obstacles to adopting VR programs are highlighted in this research, including issues with cost, internet reliability, and combining virtual reality with clinical practice. VR can provide high-quality surgical training in settings with limited resources, and participants' positive reactions suggest that it is worth considering. The development of extended reality (XR) hubs and distribution of resources via mobile networks are key strategies for the expansion of this effort.

Virtual reality has the potential to revolutionize surgical education, but additional study with a group of controls and ongoing evaluation is needed to draw any firm conclusions about its long-term impact in training environments. The use of VR in medical education, particularly in underprivileged areas, is a significant step towards improved surgical training on a worldwide scale. This will allow for more accessible and inclusive learning experiences.

1.7 CONCLUSION

The first virtual reality training session for global surgery's emergency and critical procedures yielded very favourable qualitative and quantitative results. To facilitate the scalable distribution of material that is appropriate to local settings, the design approach highlights the significance of physicians, academics, educators, and technologists collaborating across LMICs and HICs. To fill the gaps in clinical education, there is a great need for virtual reality surgical training and its integration into current local educational programs. VRiMS has promised to hold more events to expand upon the knowledge gained. Qualitative research revealed many

important issues, such as advantages, disadvantages, and future possibilities, that can guide VR-enhanced worldwide surgical education programs. Education is the main focus of this research, but there is growing evidence that next-generation technology and videoconferencing are transforming surgical instruction [17]. In conclusion, we show that postgraduate surgical teaching via remote VR has been successfully scaled up. This demonstrates the tremendous potential of XR technology to improve healthcare systems and encourage capacity-building globally.

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