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Work-in-Progress—Embedding and Evaluating Virtual Reality Sepsis Simulations into Online and Distance Learning across Multiple Healthcare Professions

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Abstract. Virtual Reality (VR) simulations have the potential to help healthcare practitioners learn to manage events that are infrequently encountered in practice but of high importance to their professional capabilities. They could be particularly valuable in online and distance education where VR could provide a flexible way to train practitioners regardless of the location and time. However, there are challenges and unknowns in how best to effectively support diverse learners in this teaching model. This paper summarises relevant literature and describes work in progress to devise and trial a VR Sepsis simulation activity with a virtual patient with both Nursing and Social Work students studying online. The study evaluates the benefits and challenges of both headset and browser-based VR for these activities, exploring how interactions with patients and other healthcare professionals can be enhanced and the practical and pedagogical requirements for learners studying online.

Keywords: Virtual Reality, Healthcare, Simulation, Online Learning, Nursing, Social Work.

1 Introduction

The use of simulations in healthcare education is well established. During the COVID19 pandemic, for example, the UK Nursing and Midwifery Council enabled the increased use of simulations, raising the bar to a maximum of 600 out of 2,300 total required practice hours, a regulation, which subsequently has been made permanent [1]. VR shows promise in extending this and enhancing access to realistic simulation-based learning. However, many questions remain about how VR simulations can be best used to support particular modes of learning, and different subject areas. Online and distance learning (ODL), while offering greater flexibility and widening access to higher education at scale, creates its own practical and pedagogical challenges to the integration of VR simulations.

To better understand these and develop appropriate decisions, we are undertaking a research project to trial a VR simulation activity for students studying across Nursing and Social Work qualifications in a large ODL institution (The Open University UK). Key questions guiding this research include:

• How can VR simulations be adapted and embedded into the curriculum for students across different healthcare qualifications and roles?

• How can the experience be provided flexibly for students at a distance (including via VR headset or browser, and with appropriate introductory and debriefing activities) and how do these features impact on the quality of the experience?

• Given the importance of soft skills and collaborative working to effective healthcare delivery, what opportunities are there to enhance dialogue and interaction with virtual patients and with other healthcare practitioners in simulations?

Our trials are addressing these questions by testing a VR platform and Sepsis-related simulation activity, across headset and browser-based delivery conditions and with students from both qualifications. Looking forward, a further phase of work will draw on the findings to enhance the dialogue and cross-role elements of the simulations.

2 Related Literature

2.1 The Potential and Challenges for Simulations

The use of objective, structured simulated clinical experiences (OSCEs) using 'patient actors' has long been a part of the education and assessment of trainees in medicine and nursing [2,3]. The value of simulation lies particularly in the opportunity it offers for learners to encounter low frequency but high risk patient care scenarios in a safe environment where they are unable to do any harm [4]. Furthermore, complex and often severe conditions such as sepsis may require such highly specialized and expert care, that nurses in training may have few opportunities to practice providing. As such, simulation offers the potential for learning experiences which prepare students for practice which are rare, high risk and offer little margin for error.

Research has demonstrated the effectiveness of simulation in terms of impact on knowledge retention [5]. Traditionally, simulations have taken place face-to-face in specially built facilities and has over time, diversified beyond the use of human actors to the use of manikins [3]. Advancements in technology also led to the facility for e-simulation [6], and to the development of immersive VR simulations for various training purposes, including as an alternative to standard physical OSCEs, potentially providing a new means of assessing knowledge and competencies [7].

VR simulations are presented as potentially overcoming several challenges associated with delivering training across healthcare professions. A range of ethical, patient safety, practical and resource issues exist with traditional approaches and make VR simulations an attractive option [8]. Not least within these is the need for growth and reform of healthcare training, required to underpin effective healthcare provision in the future [9], and the limitations of opportunities for real-life experiential learning in workplace settings.

Research to date provides a general sense that immersive VR shows promise for higher education [10]. Online learning, often provided at a distance and with open access to all who want to learn, provides flexible opportunities for people to upskill and gain qualifications as they work regardless of their location. This is particularly suited to areas such as Nursing and Social Work, but presents challenges in delivering authentic learning experiences and training for interpersonal skills [11]. There may therefore be particular opportunities for VR in this space. However, the study environments that students are situated in for their distance learning experiences are very different from those of campus-based students, being more intertwined with their daily living, and less well understood by their teachers or institutions [12]. VR simulations do not stand alone and further work is needed to understand how best to embed them in each subject curriculum and to provide effective introductions, scaffolding and reflective debrief activities [13], which again may need to be tailored for the ODL context.

The type of simulation we are evaluating have been trialled in medical training [13] but have further potential to support learning in wider healthcare professions. It is also important to evaluate how these simulations can be effectively delivered in an ODL context and any challenges students face to them. Of particular interest here is how students should access the simulation from their home or other study environment. Currently, it may be more practical to expect browser-based access rather than assume VR headsets will be available to the student, though with rising availability of headsets, this situation might change in the near or medium-term future. A survey of students at our institution, for example, shows that in 2022, almost 8% reported to have a VR headset at home.

While we could expect the availability of immersive VR to continue to rise, we also need to consider the various barriers students may face to using headsets and VR platforms, including due to disabilities (e.g. [14]), expectations for space to be made available in the home environment [15], and cost [16].

Browser-based access or other means of engagement may overcome these barriers, but if this reduces the experience or outcomes then there is further concern for equity and engagement. Studies comparing headset and computer-based VR in other contexts, such as lectures, have produced mixed results to date [17]. Researchers have noted that the different technologies that can be used to access VR can influence experiences and learning in multiple dimensions. For example making gestures using controllers in a headset-based VR experience could lead to a different understanding of actions in a procedure when compared to doing the same simulation through a smartphone interface, but these may also have different affective influences on the learner. More immersive delivery mechanisms have been found to have a positive effect on knowledge gain in some evaluation studies but not in others, suggesting a complex picture where more research is needed [18].

2.2 VR Simulations in Nursing Education

Reviewing literature, the Royal College of Nursing finds good evidence for the benefits of simulation-based learning in general, and that simulations can replace a substantial proportion of clinical placement hours with comparable learning results. Regarding VR-based simulations, they note cost and limited access to equipment as barriers, but also the trend to greater use of digital technologies in training post-pandemic, which is likely to

deliver rapid evolution in this space. In this, evaluating quality and identifying best practice is paramount, and further research is needed to understand effective strategies [19].

Recent years have seen a growth in research into the use of VR simulations in Nursing education, but there remains limited understanding of how this can be effectively used, and the need to focus further on the potential to enhance soft skills has been highlighted [20]. Studies to date do provide evidence that VR can enhance self-efficacy [21], and knowledge when compared to other methods such as physical mannequins or simple computer-based simulations, but also suggest more work is needed [22]. Recently, mixed reality approaches are being evaluated, complementing the use of XR with haptics, using reduced functionality physical mannequins [23].

2.3 VR Simulations in Social Work Education

Huttar and Brintzenhofe-Szoc conclude from a review that VR has a beneficial impact on social work practice learning [24]. It is very likely that further VR simulations will be developed to support practitioners' learning and development due to the rapid development of technologies and increasing expectations for flexible learning [25]. The majority of simulations have been created for students rather than practitioners [26], and the opportunities for simulation in this area are well recognized, with particular potential for teaching of the wide range of interpersonal competencies a social worker needs to develop and demonstrate [27]. However, no studies have looked at the development requirements and specifications for ODL Social Work students to learn through VR.

Here, and in nursing, designing for learning through dialogue and interaction with patients and other professionals is a key element, and one where conversational AI can play a role [28]. An example of this is a pilot study which they used a VR simulation of a patient to help social work students improve their assessment skills. The virtual patient, who was projected onto a screen to appear life-size, was able to respond to their questions using voice recognition software. Students saw four different virtual patients over the course of four sessions, allowing them to improve their assessment skills week by week. The advantages identified include that multiple students can engage with their own version of the virtual service user simultaneously, making the process much more time effective. The process does not rely on a human actor who requires breaks and is likely to become tired from repeating the same scenario multiple times in a single day. Furthermore, the simulation can be restarted or paused at any time [29].

3 Methodology

This collaboration initially developed through discussions between educational technology researchers and Goggleminds, a company producing VR simulations for healthcare training. Colleagues involved in research and teaching in relevant healthcare areas joined to create the project team and we then all explored how and where simulations could play a role, and the development of research questions that address key issues to further understand before VR simulation was employed at greater scale in teaching and learning.

Our research questions lead us towards an approach with two conditions and two groups involved in each: A condition in which participants take part in the simulation activity using a VR headset, and one in which they take part using a web browser and standard computer. The platform supports both conditions to be delivered with the same simulation design.

The scenario chosen for the simulation was a patient with sepsis. Sepsis is an unregulated immune response to an infection which can result in organ and tissue damage [30]. In a 2016 report from NHS England [31] on sepsis education and training, it was argued that this condition is a leading cause of death in the UK, second only to cardiovascular disease. The report goes on to argue that a contributing factor to the potentially 44,000 avoidable deaths a year from sepsis in the UK was a failure to promptly recognize and treat the condition. The Sepsis Six bundle was shown to reduce the relative risk of death by 46.6% when delivered to patients within an hour. Consequently, this simulation was developed around the Sepsis six core treatment tasks of giving oxygen to the patient, taking blood cultures, giving antibiotics, fluids, taking a lactate level and monitoring urine output [32].

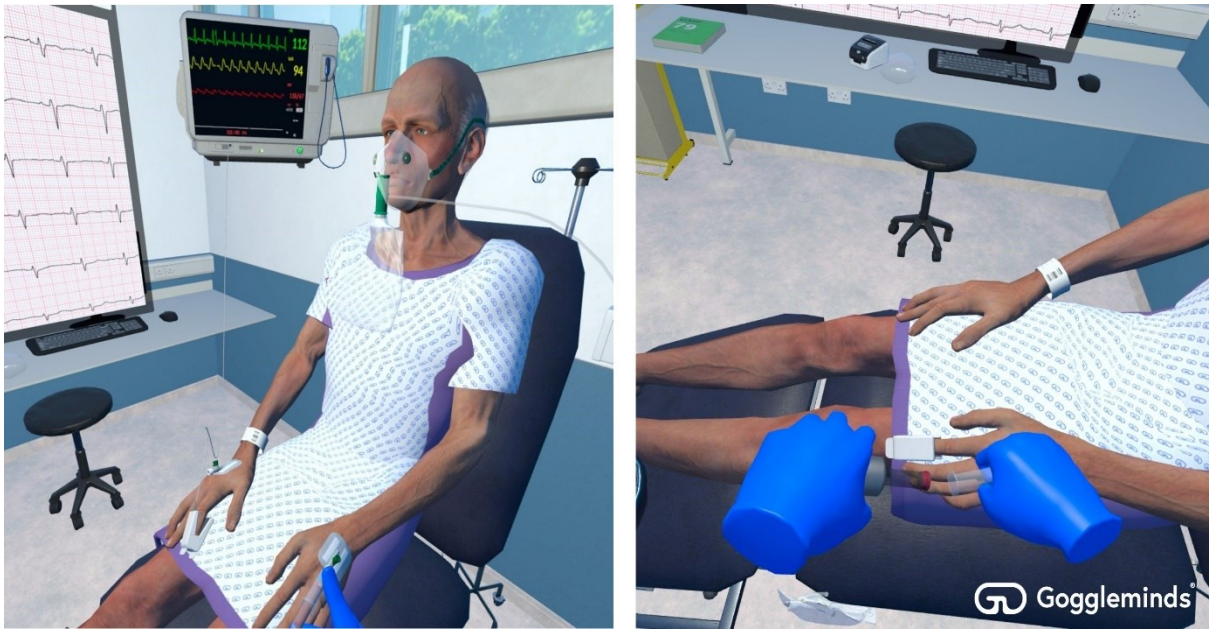

Fig. 1. Virtual patient interaction in the Goggleminds Platform.

It is evident that students on different qualifications can benefit from similar simulation-based training on core competencies and skills, with Sepsis being an example of such an issue where ideally all workers in healthcare contexts will have the skills to identify and respond to this life-threatening condition [30]. The team agreed that undergraduate students in Nursing and Social Work could both benefit from engaging with a simulation to enhance their learning in this area, but that they would need separate pathways for recruitment and to ensure that the activity was delivered in such a way as to be appropriate to their existing knowledge and expected learning outcomes. In this regard, experts in teaching in each subject area develop wraparound learning and guidance to introduce and debrief students according to the prior knowledge and ideal learning outcomes, and the simulation context and expectations will be adapted to address differences in the ways in which a social work practitioner will approach sepsis care when compared to a nurse. We will compare the experiences between these student groups with reference to these adaptations as well as their wider studies.

To assess the extent to which the students' experiences of the VR headset and browser-based versions of the activity differ on important dimensions such as immersion, intrinsic motivation and cognitive load, the Immersive Technology Evaluation Measure described in [13] will be used. Alongside this, a debrief discussion will be used to explore the impact of the activity on the students, their experiences and suggestions for improvement. We hope to then build on these initial trials and employ further methods to capture data on different dimensions of learning and experience.

The findings will be used to develop strategies through which simulations can be effectively embedded into the learning of ODL Nursing and Social Work students, and to inform the further development of simulations and the platform, particularly in relation to dialogue-based interaction with the virtual patient and virtual staff.

4 Current Work and Next Steps

By devising an approach to embed VR simulations into ODL teaching for both Nursing and Social Work students, we are exploring the practical and pedagogical requirements for this to succeed and provide a good student experience and learning outcomes. Evaluating both browser and headset-based experiences will enable greater understanding of the benefits and differences in these for these students. The evaluations are about to begin so findings can be shared at the conference.

This study is a first phase of work which can inform strategies to increase the use of XR in healthcare teaching through ODL. Through this, the work can support effective healthcare provision flexibly and at scale.

A further focus we will explore with students through the evaluations is the ways in which conversations with a virtual patient can be enhanced, and how simulations can enable learning about the important cross-role awareness and communications skills which are much needed by nursing, social care and other healthcare professionals, and are challenging to develop through existing teaching methods. We aim that new designs for

realistic and rich dialogue and for collaborative use of XR simulations across disciplines will result from these efforts.

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