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Development and operationalisation of a mixed reality interactive virtual patient application for online nursing Objective Structured Clinical Examinations

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Abstract

During the 2020 iteration of a Bachelor of Nursing Clinical Health Assessment skills course delivered in Singapore, the sudden cancellation of all face-to-face classes due to the COVID-19 pandemic resulted in innovative strategies being required and quickly created to enable students to successfully complete clinical skills laboratories and Objective Structured Clinical Examinations (OSCEs) online. However, the realism of the experience was rudimentary. At the end of the 2020 teaching semester, and the possibility that the next iteration of the course would also need to be online, it was decided to explore technologies to provide a more realistic and interactive user experience for the 2022 iteration of the Clinical Health Assessment skills course and particularly for the OSCEs. A research project was initiated in 2021, to develop and test the use of virtual or mixed reality applications for online simulated learning and clinical skills assessment. This paper discusses the development and operationalisation phases of a mixed reality interactive virtual patient application used for online OSCEs in a Clinical Health Assessment skills course.

Keywords: Educational technology; mixed reality (MR); online Objective Structured Clinical Examinations (OSCEs); virtual assessment; virtual patients.

Introduction and background

Over recent years, the global COVID-19 pandemic and resultant biosecurity measures have brought many challenges for universities and colleges, including those providing nursing education programs. While many courses can be taught and assessed effectively online, delivery and assessment for courses that focus on clinical skills have been somewhat more challenging (Crawford et al., 2020; Dewart et al., 2020; Grafton et al., 2021). As the COVID-19 pandemic began to impact Singapore in early 2020, a Clinical Health Assessment (CHA) skills course in a Bachelor of Nursing (BN) program provided by an Australian university for nurses in Singapore, was quickly moved online. Rapid development of imaginative and innovative strategies to provide the clinical skills laboratories and the Objective Structured Clinical Examinations (OSCEs) online enabled course learning outcomes to be met, and thus maintained academic continuity for students (Grafton et al., 2021).

Education for healthcare practitioners is ever-evolving as new and emerging technologies impact on the way education is provided (Co & Chu, 2020; Mtshali & Harerimana, 2019). Research recommends that nursing programs continue to adapt and transform (Ion et al., 2021) and report on the successful use of virtual learning platforms not only to conduct effective teaching, but also to facilitate students' clinical learning experience (Co & Chu, 2020: Lee & Xiong, 2022; Manakatt et al., 2021; Schmitz et al., 2021). At the end of the 2020 teaching semester, and the likelihood that the next iteration of the CHA course would also need to be online, it was decided to explore opportunities for crafting a virtual or mixed reality experience combining simulated patients and a virtual learning environment to further enhance the students' sense of reality and interactivity for the 2022 course iteration and particularly for the OSCEs.

A project was initiated in 2021 to develop, test, implement and evaluate an interactive virtual means of online clinical skills assessment of nursing students. A research team was assembled resulting in members from three different

disciplines and this paper discusses the development and operationalisation phases of that project. The research team was led by the BN Program Director (Singapore), and initially included the academic convenor for the CHA course, and the BN Health Technical Services team leader. Experience with applications, virtual and augmented technologies was brought to the team via the addition of a senior academic from the School of Pharmacy and Medical Sciences, and two academic staff from the College of Art and Immersive Design. Each member of the interdisciplinary team brought different perspectives, experience, and expertise and gave rise to creativity that would not ordinarily be found in a team from within the same discipline (Grant et al., 2023; Zhang & Wang, 2021).

Development and testing of the app

As the CHA skills course was to be delivered online by the academic convenor in Australia, for nurses in Singapore, several considerations for a virtual application for clinical skills assessment were prioritised: These included that the application would need to:

- be of low or no cost to access for students and staff;
- require no special equipment, such as specialised goggles;
- be accessible on any electronic device;
- be able to be applied in virtual private rooms / channels for OSCE assessment purposes;
- include culturally appropriate aspects for Singapore.

Developmental considerations also included the technical aspects such as the platform and the type of software or program used so that it would work seamlessly within programs and the existing platforms in use on University's course sites. Within the university's School of Nursing, the course remained embedded within the Blackboard learning management system (LMS). However, Microsoft Teams was being increasingly used, particularly as a platform for tutorials and discussion forums (Henderson et al., 2020). Thus, a Microsoft Teams course site was created for the CHA course and students provided with guidance for use.

Different educational technologies as well as technologies from outside the educational paradigm were experimented with during development. A mixed reality interactive virtual patient application was built using the Microsoft Power platform with life-like stylised virtual patients constructed using Unreal Engine and Meta-human creator (Epic Games Inc., 2004-2023), for deployment via the course Microsoft Teams site (Grant et al., 2023). The complex technical details of development are discussed in other publications by the team and are not the focus of this paper. For practical purposes, the interactive virtual patient application is abbreviated and referred to as the 'VR app'.

For this course, three virtual patients were developed from the scenarios of the previous iteration of the course with two scenarios for each virtual patient, providing different body systems assessment options for the OSCEs. The virtual patients' names and physical characteristics were designed with sensitivity and relevance to reflect the ethnic and cultural demographics of the population in Singapore, and to pay cognisance to the concept of decolonisation pedagogy (Sahjahan et al., 2022). An outline of the patients and scenarios is provided in Table 1.

Table 1: Virtual patients and scenarios.

Patient 1 (Irfan Bin Rahman)		Patient 2 (Mary Leong)		Patient 3: Rasheeda Khalid	
Scenario 2A	Scenario 2B	Scenario 1A	Scenario 1B	Scenario 3A	Scenario 3B

One virtual patient (Patient 1: Irfan Bin Rahman) was selected for practice scenarios, and access via an open 'OCSE practice channel' in Teams, was provided to students one month before the OSCEs, to allow students to not only practice the process for the OSCE but also to develop familiarity with using the VR app. The remaining two patients' and scenarios were used for the formal OSCEs.

From past personal experience, students in Singapore use a range of different electronic devices to access online content in their courses. The research team, therefore, experimented with access, appearance, and usability of the VR app on a range of devices including laptop computers, tablets and mobile phones, and with different browsers, to mimic the different ways students may access their course content and online assessment. Research reports that student experiences using educational technology applications must be considered (Lee & Xiong, 2022). During the final development stage, a small group of past students who had completed the OSCE in the previous online iteration participated in a live demonstration of the VR app. This allowed those students to compare the VR app OSCE process to the previous online OSCE process and provided valuable information and feedback for refinement. A brief survey was then sent to the 2022 cohort of students to gather feedback on their experience of the VR app in the open OSCE practice channel with Patient 1 (Irfan Bin Rahman). Feedback from students informed final minor adjustments to the VR app to create the final version (Version 2.0). The VR app in the open OSCE practice channel was then updated to the final version, while the VR app with the other two virtual patients and their scenarios was deployed within the examiners' private channels ready for the OSCEs.

The VR app and functionality

In terms of functionality, the VR app provided a home page with a 'Start' button and entry into a virtual 'room' for the selected scenario (Figure 1). While the entry room was usually the same for each patient scenario, the VR app provided for individual scenario-specific details and assessments.

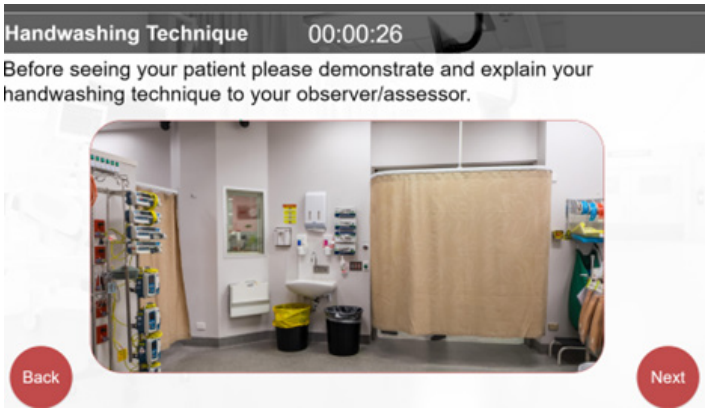

Figure 1: Virtual entry room.

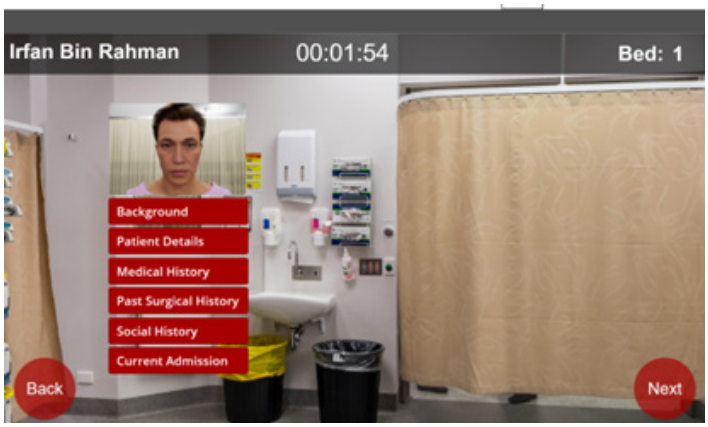

Figure 2: Practice scenario with clickable tabs for patient information.

After progressing through the scenario-specific patient information, the students moved forward to more specific assessment. Icons (shown in Figure 3) were used to indicate the various sections of physical assessment for the patient in the scenario. The icons represent the key sections of the OSCE assessment criteria: general patient survey, vital signs interpretation, body systems assessment (two systems specific to the particular scenario), additional assessments applicable to the scenario (e.g., pain assessment) and clinical handover. The description for the assessment the icon represents appeared as the student hovered over each icon. The student entered the chosen section by clicking on the icon, and when completed, they click the 'back' button, and proceed to the next icon for the next part of the patient assessment.

Figure 3: Icons for assessment.

For the various body systems assessment, a selection of views of the relevant virtual patient allowed the student to select the most appropriate view (e.g., posterior or anterior view of the chest for respiratory system assessment) and embedded interactive tools enabled the student to draw on the image to indicate examination landmarks (an example is shown in Figure 4).

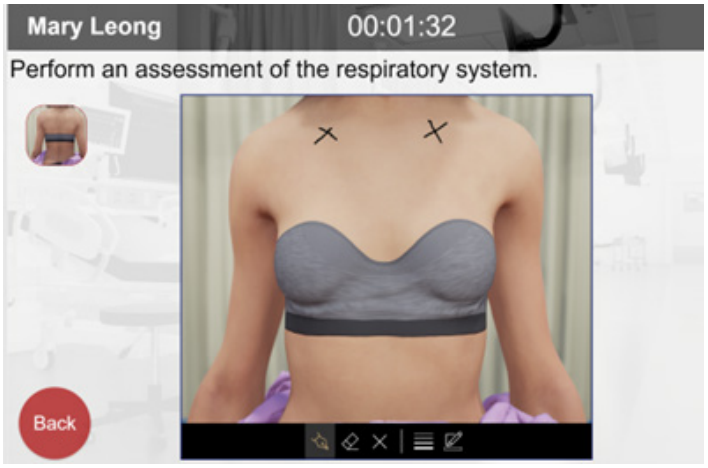

Figure 4: The virtual patient with view options and interactive tools.

Operationalisation – the process for the OSCEs

In addition to the open OSCE practice scenario using the VR app, detailed written information and an online workshop were also provided to support students to become familiar with the online process and assessment expectations for the OSCEs. With 104 students enrolled in the course, a five-day period was allocated for OSCEs, and students self-enrolled to a selected day and time on a live spreadsheet on the course Microsoft Teams site. Once completed the spreadsheet was downloaded and used by the convenor during OSCEs to manage the schedule and student attendance. Three examiners were rostered to cover the exam period, with two examiners operating at any one time. The examiners were all experienced and qualified Singaporean nurse educators who had previously tutored in the course and examined OSCEs both face-to-face and in the previous online format. The OSCEs were conducted in the course Microsoft Teams site, across several time zones with the convenor based in Brisbane, Australia, 103 students and two examiners in Singapore, and one student and one examiner in England. Examiners were each provided a private (locked) channel, with students given access by the convenor, one at a time, to an examiner's channel, to facilitate uninterrupted privacy and confidentiality during each individual student's exam. The VR app with Patient 2, (Mary Leong) and Patient 3 (Rasheeda Khalid), (and the two options for each) was linked within each examiner's private channel with the particular patient and scenario being given to each student at the time of their exam.

Although the convenor had access to the examiners' channels, this was not used unless requested by the examiner to join them. The WhatsApp instant messaging service was used for communication between examiners and convenor. An 'OSCE Waiting room' channel was set up and managed by the convenor with 'meetings' scheduled for the morning session and evening session for each day. Such 'meetings' provided the opportunity for live interaction with students 'joining a meeting' 15-30 minutes before their scheduled OSCE to ensure their technical equipment was working effectively and to manage anxieties.

Within the private examiner's channel, once identity checks were completed, the student was directed to share their screen and click on the selected scenario. Having the student share their screen and open the VR app for the scenario placed the student in control of their progress through the scenario and thus realistically access patient information, examine, and use interactive tools to demonstrate relevant clinical examinations and physical landmarks. Throughout the OSCE, the student and examiner were able to see and interact with each other via real-time on-screen camera and audio feed, while the scenario continued to be displayed and function on the shared screen. Thus, the student was able to clarify and demonstrate skills such as examination techniques, with their hands to camera, or indicate a landmark on their own body to provide clarification. Examiners were provided with electronic marking criteria which were completed for each student and emailed to the convenor for checking and entry of marks to the course site. Examiners were requested to record each individual OSCE to allow for moderation and in the case of any dispute of performance. At the completion of an individual OSCE, the examiner stopped the recording, ended the 'meeting', completed documentation, and messaged the convenor when ready for the next student. A detailed description of the process for OSCEs is provided in Appendix 1 – 2022 OSCE Process Flow Chart. A random selection of recordings was reviewed by the convenor for moderation prior to releasing student marks, and then all recordings were deleted.

Discussion

As bio-security restrictions have continued to ebb and flow in response to risk, it could be argued that the COVID-19 pandemic has provided a catalyst for the rapid development, expansion and innovative use of education technologies (Khamis et al., 2021; Manakatt et al., 2021; Miller & Guest, 2021). For the CHA course, the ongoing suspension of all face-to-face teaching and assessment provided an ideal opportunity to explore virtual reality technologies in order to provide a more realistic user experience in completion of online OSCEs than the previous experience. This paper has reported the developmental and operationalisation phases of the larger project. Evaluation of user experience and effectiveness of the VR app was completed and is reported in other publications. A summary of the project and results was also reported in a poster presented at the 2022 NETNEP 8th International Nurse Education Conference (Grafton et al., 2022).

In an uncertain world, educators need to be prepared to deliver courses online (Matthias et al., 2019). The journey to find a more realistic and interactive user experience for students' clinical skills learning and especially the OSCEs, while ensuring the integrity and rigour of the OSCE as an assessment item led accessing experience, knowledge, and skills outside the nursing discipline. In this project, the different disciplines and members of the research team brought different perspectives and resulted in greater creativity than may have been found within a team limited to one discipline (Grant et al., 2023; Zhang & Wang, 2021). The diverse team provided a valuable opportunity to experiment with different technologies at the development and testing stages and helped reshape the project to find a creative functional application of technologies to enable students to meet the course learning outcomes in the online space.

Conclusions and recommendations

Final reflective observations of the convenor concluded that purposeful exploration and use of technology and a willingness to adopt such technologies can lead to creative solutions to facilitate realistic and interactive learning and assessment. While shown to be valuable for when face-to-face classes are not possible, there is potential for other applications such as opportunities for students across health disciplines to practice before major face-to-face clinical examinations. In line with feedback from users, and results of this project reported in another paper, further development of the mixed reality interactive virtual patient application (VR app) incorporating vocal responses and purposeful movement of the virtual patients is being explored.

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Appendix