Knoo Lee-UMSAEP Progress Report YR 2023-24

Project Background

Rapid advancements in nursing education have been achieved through simulation-based practica, mimicking real-world hospital scenarios. However, a critical gap persists: the inability to replicate essential escalating situations crucial for nursing students' preparedness. Vital clinical scenarios such as cardiac arrests, syncope, and hepatic encephalopathy remain underrepresented, potentially impeding the readiness of newly graduated nurses. Current solutions include live simulations, but these fall short due to their resource-intensive nature, including hiring actors, limited faculty-to-student ratios, and scenario-specific equipment procurement.

Contemporary nursing education has begun adopting VR simulations to bridge these gaps (Harmon et al., 2021; Shorey & Ng, 2021) . However, prevailing research endeavors show a tendency to rely on privately held, profit-driven entities (Oxford Medical Simulation, 2022; SimX, 2023). These external entities either custom-develop scenarios or market pre-packaged solutions, both of which come at a significant financial cost. Moreover, VR technology in health education may generate substantial proprietary data encompassing motion, decision-making, and other critical aspects, risking monopolization by private companies. The dearth of interoperability due to these entities' market control could compound the issue, raising concerns more profound than mere financial implications.

In light of these challenges, we proposed the development of an open-source VR simulation as the first step towards building a comprehensive and sustainable VR training platform. By democratizing access to VR technology in nursing education, we aim to empower educators and institutions to develop and share scenario modules freely. This approach not only mitigates financial barriers but also circumvents the monopolization of proprietary systems (Lakhan & Jhunjhunwala, 2008). Through open-source collaboration, we envisioned a future where nursing students and professionals alike can harness the potential of VR to confront and master critical escalating situations, enriching their practice and contributing to reduced turnover rates (Currie & Carr Hill, 2012; Han et al., 2009; Shin et al., 2019).

The initial stage involved the creation of a VR nursing simulation; benefitting from the expertise of Dr. Fang Wang from the MU Department of Electrical Engineering and Computer Science. Dr. Wang serves as the principal investigator of the Immersive VR Lab (iVRLab) and has notably spearheaded various research endeavors in the realm of VR training, as evidenced by her research publications (Murrell, Wang, Aldrich, & Xu, 2020; Schrader, Gebhart, Garrison, Duchowski, Lapadatescu, Feng, ... & Petty, 2021; Wang, Xu, Feng, Vesga, Liang, & Murrell, 2020; Xu & Wang, 2022). The iVRLab was originally established to furnish an immersive and embodied training arena catering to engineering students, facilitating tasks like manipulating silicon wafers and engaging in microfabrication photolithography (Xu & Wang, 2021). Although its

conception was tailored to engineering students, the technological elements it encompasses—such as the integration of goggles and controllers to enhance immersive engagement with VR—hold broad applicability within educational contexts. This is particularly relevant for our current undertaking, involving the training of nursing students.

In collaboration with Dr. Wang, we completed an initial pilot of a Nursing VR simulation (See Figure 1). This simulation was tailored to address emergency room scenarios involving cardiac arrests and is slated for finalization by the end of 2023 (Lee et al., 2023). A first phase included deploying this simulation to students enrolled in the MU Sinclair School of Nursing in the Spring of 2024.

Figure 1. Simulated Hospital Emergency Room (Development In-Progress)

Project Aims

Our proposal outlines the following specific aims, focusing on the initial development and testing of an open-source VR simulation:

Aim 1: With an interdisciplinary team, develop, test, and refine a scenario-based VR simulation depicting a nurse in the emergency department responding to a cardiac arrest. (MU)

Aim 2: Evaluate the feasibility and usability of the VR simulation in supporting nursing students' readiness to practice by conducting focus group interviews of nursing faculty at both MU & UWC.

Aim 3: Adapt, disseminate and deploy the VR simulation to nursing students at MU and UWC, comparing pre- and post-surveys and exploring implications for global education organizations.

Aim 4: Establish a strong connection between MU and UWC for future collaborations and grant applications.

Methodology

The research design of this study encompasses a comprehensive blend of qualitative (Aim 2) and quantitative (Aim 3) methodologies to explore various dimensions of nursing VR simulation, specifically focusing on readiness to practice, presence, immersion, and system usability. The investigation will entail conducting interviews and/or surveys among a representative sample of faculty and students from MU and UWC.

Notable UWC Visit TO MU Sinclair School of Nursing Activities

1. Three Faculty Members (Prof Chipps (Digital Chair Funding) Dr Hoffman & Ms Petersen) visited University of Missouri at the Mid-April during Campus week being held at the Sinclair School of Nursing with participating activities below:
    a. Provided joint lecture for graduate students in the Sinclair School of Nursing including PhD, DNP, and MSN students titled “Enhancing Nursing/Healthcare Simulation through the Integration of Virtual Reality: Contextual Challenges in Mid and Low-Income Countries”.

b. Provided joint lecture for undergraduate students in the Sinclair School of Nursing titled “Enhancing Nursing/Healthcare Simulation through the Integration of Virtual Reality: Research Projects at MU and UWC”.

c. Attended technology demonstration session held at iVRlab of Dr. Fang Wang and Prof. Scottie Murrell – College of Engineering with research assistants including virtual reality simulation development, motion capture, and AI-driven virtual reality assets development solution using softwares including Reallusion. Discussed specific direction of how to proceed with the current collaboration and expanding the scope of the nursing VR simulation research endeavor between MU and UWC.

d. Attended technology demonstration session held at the Immersive Visualization Lab led by Dr. Jong Bum Kim and Dr. Debora Verniz with research assistants including currently developed virtual, and extended reality assets and simulations from the department of architectural studies and discussed future potential projects.

Notable MU to UWC Visit Research Activities and Products

1. Developed and conducted Nursing VR simulations for students and faculty members at UWC, followed by the administration of predesigned pre- and post-questionnaires and focus interviews. Data collected:

    1) Pre- and post-questionnaires, with the data collected, captured, and currently undergoing analysis.

    2) Three focus groups were conducted—one with clinical facilitators and two with students. The data from these sessions is currently being transcribed.

2. Lee, K., Wang, F., Hoffman, J., Peterson, M., Lewis, S., Chipps, J. Assessing the Feasibility of In-House Development of Nursing Virtual Reality Simulations for Global Intercontinental Implementation. [In Development led by MU; UWC leading a separate effort on collaborative publication]

3. Media Interview: The university's media officer, Ms. Harriet Box, interviewed the researchers to report on and update the institution regarding advancements in clinical skills development using Virtual Reality in the nursing field and its related benefits. The article is scheduled for publication in Term 3 of the academic year.

4. An intern, Mr. Lahai Rois Iradukunda from UWC Nursing, shadowed the Nursing VR sessions and gained insights into conducting this type of research under the guidance of Dr. Knoo Lee. (See the appendix below regarding the UWC report on the activity conducted in Cape Town).

Prospects for Future Collaboration

1. Developed a UMSAEP extension proposal to expand the scope of current research scope to attain statistical significance regarding the application of the VR product.

Appendix. UWC Report regarding the VR Nursing SIM Collaboration during MU Visit to Cape Town

University of Missouri in collaboration with University of the Western Cape school of Nursing VR simulation report

Date: 10-14 June 2024
Venue: University of Western Cape, Prefab C2

1. Introduction

Collaboration between University of the Western Cape school of nursing and University of Missouri Sinclair school of nursing. Ass. Prof Knoo from university of Missouri is working with Prof Chips Jennifer, Dr Jeffrey Hoffman and Ms Meghann Petersen to test the Virtual reality (VR) game which was developed by the university of Missouri in their long running aim to develop and provide open-source VR application to different Institution that may need to use them. They are planning this project to tackle the cost which is accompanied by buying the VR application from the privates' company where they charge a lot of money and there is no hope that after they provide the application, they will be able to maintain the application with no additional cost.

To overcome the high price of this technology they started the collaboration between their faculties of engineering and architecture to start developing different VR simulations. But they first need some research and data to test if the initial simulation they have is acceptable. That's why they conducted this research week where it was filled with data collection from the students and clinical supervisors as well as lecturers.

2. Objective(s)

- Implement the developed VR emergency ICU simulation
- Collect Quantitative and qualitative data
- Introduce the collaboration between both universities to the academia

3. VR Simulation Content

The simulation was about a professional nurse (A player) who was in an emergency ward, she was in charge of three patients. Upon the start of playing the simulation the Nurse is supposed to check the vital signs of the patients and while checking the vital signs for the last patients, one of the patients will get cardiac arrest, and one of the clinicians will shout for help for that patient. As a professional nurse (Player) supposed to identify the patients who are under cardiac arrest and do the assessment that is needed, the assessment includes shaking the

patients' shoulder for the response and checking for the femoral pulse to feel if it is available. With no response, a Professional nurse(Player) immediately had to push the code blue button in which upon touch , the clinician will come to start the CPR. While the professional nurse is supposed to allocate the emergency trolley and bring it to the emergency sites.

The player is requested to add the defibrillator pad to the patients, and initiate the shock to the patients, but before shock the player had to make sure all clinicians stayed clear from the patients. The professional nurse (Player) had to stay close to the patient to observe while students took over the CPR, upon completion the player had to go reassess the patients and feel the femoral pulse.
Upon feeling the femoral pulse, the Professional nurse had to call ICU to inform them about the situation and that the patient is stabilised now.

4. Visual representation

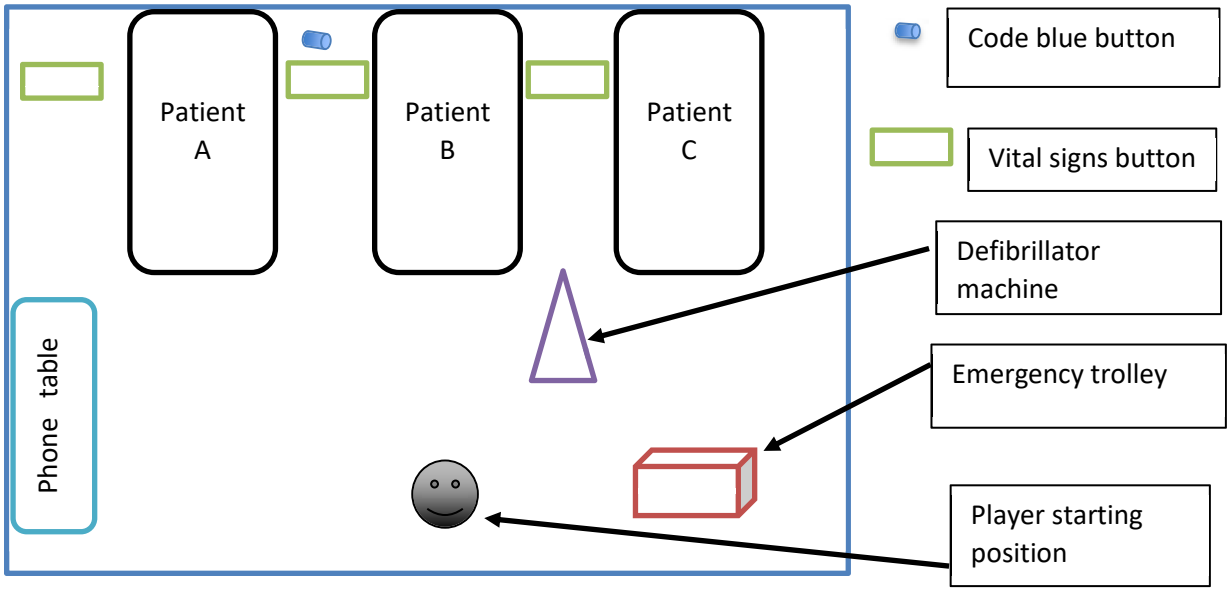

Fig 4: VR emergency scenario

5. Audience perception

Clinical supervisors and Students were all nervous before the use of the VR but upon the orientation and telling them about the simulation they were all calm, they verbalised that they enjoyed the clinical simulation, where they felt like they were really in the hospital

environment, and they had to do all they can to keep the patient alive by managing the cardiac arrest.

In addition two set of data were collected;

1. Pre and post questionnaires were administered that measured using the readiness to practice by using the Readiness to Practice Survey (CFRPS) (Casey et al., 2011); and the Nursing Anxiety and Self-Confidence with Clinical Decision-Making Scale (NASC-CDM)(White, 2014). In addition, we will use the Short Version of Game User Experience Satisfaction Scale (GUESS-18; Keebler, 2020) for usability and NASA Task Load Index (NASA-TLX) for task load of the VR Simulation (Hart, 2006).

Data have been collected, captured and are in the process of being analysed

2. Focus Groups x3 were conducted - one with clinical facilitators and two with students. Data is currently being transcribed.

6. Challenges and Concerns

Technical issues encountered:

1. The room scale was blocking the free will to move.
2. The double touch of the blue code button caused the system.
3. Mistakes touch of certain buttons changed the positioning of the simulation.
4. Defibrillator pad running out even though not attached correctly.
5. Running through the NPC with an emergency trolley.

- *Hand Placement*

Fig 1: the best way to place hands on the Metaquest oculus 3 controller

Fig 2: Grab button that are used on this VR simulation

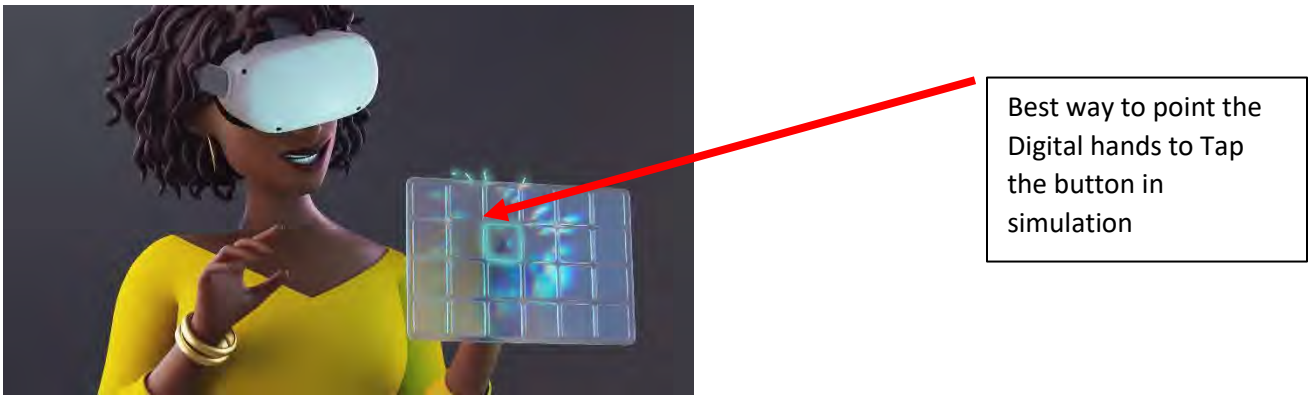

Fig 3: Visual representation of hands in VR simulation to tap

- *Nursing*
    6. The first person to notice the cardiac arrest, shout for help and start the CPR.
    7. Emergency trolleys colour blue, on side with the blue background “make it difficult for the player to locate”.
    8. Code blue button positioned behind the patients’ bed “usually located near the nursing station”.
    9. A lot of NPCs (Non-Player Characters) were blocking the player and some didn’t have a role in the simulation.
    10. Uniform difference or labelling the characters and their role (Doctors, Students, Therapist and Nurses).
    11. The pulse after reassessment, vibration felt on one controller while using the other controller u couldn’t feel the vibration.
    12. Positioning of the hands while performing the CPR and the ambu bag.

7. Recommendations

- Get a much bigger space.
- Let the user freely explore themselves, until they get stuck then intervene.
- Improve the system to fit the South African context.

8. What to learn as school of nursing

- Basic VR experiences for students and clinical supervisors to familiarize themselves and get used to this kind of technology.

9. Conclusion

It was a positive week. The intern had an opportunity to use Metaquest oculus 3 and try to compare it with Metaquest oculus 2 and reflected that as a developer it provided insight into how he can start my own project in VR and begin with linear projects and build up onward. The developed emergency simulation is linear and simple and still under development. There are some improvements that have to be included in the final simulation.