Virtual Reality Simulation in Post-Secondary Healthcare Education: What Lessons Can We Learn?

by

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D.M.LT., British Columbia Institute of Technology, 1985

Project Submitted in Partial Fulfillment of the
Requirements for the Degree of
Master of Education

in the
Educational Leadership Program
Faculty of Education

SIMON FRASER UNIVERSITY
Summer 2022

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Abstract

Virtual reality simulation (VRS) is an exciting new technique used in post-secondary healthcare education. VRS is an immersive 3D experience that allows students to practice skills in a safe yet realistic environment. However, can it provide enhanced learning outcomes to better prepare students for clinical situations? The researcher endeavored to determine the benefits and barriers for instructors and students using VRS in healthcare education. The researcher performed three one-on-one semi-structured interviews with instructors and a semi-structured focus group with four students. A thematic analysis to understand both instructor and student perspectives was conducted. The findings suggest that VRS provides a realistic environment to support students' clinical decision-making without fear of patient harm. Instructor and student motivation and attitude were noted as a factor in the success of the VRS experience. Organizational challenges associated with cost and feasibility must be considered when implementing a VRS program in healthcare education.

Keywords: Virtual reality; simulation; healthcare, education, benefits, barriers

Acknowledgements

I wish to express my deepest gratitude to my SFU supervisor, Michelle Pidgeon for her wisdom, support, and guidance throughout this project. I would also like to thank all the SFU professors who helped me put the pieces of the educational leadership puzzle together: Tina Fraser, Daniel Laitsch, Gillian Judson, and Rebecca Cox. Special thanks to Grace Dyck for spearheading the latest Master of Educational Leadership program in Prince George and encouraging me to take on this educational challenge. I am also grateful to my cohort, whose collaboration and support was instrumental during the process. Many thanks to all participants who participated in the study and enabled this research to be possible. Finally, I would like to thank my husband, Shawn, for his help in proofreading and critiquing my many assignment drafts.

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Introduction

In many healthcare curricula, simulation-based learning is a technique for practice and learning that replicates aspects of the real world interactively (Lateef, 2010). VRS has been introduced in recent years into the post-secondary educational system (Lamb et al., 2020). VRS is a computer or internet-based learning environment that immerses participants in real-world scenarios (Ke & Xu, 2020). In healthcare, VRS can help students prepare for clinical situations through multiple practice and feedback activities. This process allows the learner to become proficient in a safe environment where patient harm is not an issue. 3D enables learners to participate actively, solve problems, and interact in a virtual world.

VRS in education is a novel approach to introducing an immersive and realistic experience for the learner. Lamb et al. (2020) noted that increased learning opportunities could occur since immersion can include physiological, sensory, and psychological forms. Technology advancements have made VRS more accessible and affordable within the educational domain. Today's tech-savvy students are ready to embrace VRS; however, those unfamiliar with the technology have found VR harder to navigate (Lamb et al., 2020).

Does VRS based learning engage students in the learning process? Are educators prepared to transform curricula to include VRS? As a health science educator at a local community college, the researcher was interested in finding new and effective ways of engaging students in the learning process. From a pedagogical position that an educator is a facilitator of learning rather than merely a transmitter of knowledge, the researcher believed that students learn best when actively engaged. Exploratory learning through VRS can engage students and help them connect theory to practice actively. This study was motivated by a desire to discover the benefits and limitations of VRS to understand the implications of employing VRS in healthcare education at the College of New Caledonia (CNC).

Literature review

Literature regarding VRS in healthcare, especially in nursing education, is vast and complex (Shepherd & Burton, 2019). This literature review examined peer-reviewed journal articles regarding virtual reality in post-secondary education. In determining whether VRS is a viable alternative to traditional classroom teaching, several common themes in the research emerged; effective components of VRS, training requirements for educators, training requirements for students, VRS educational applications, and further areas for study

Effective components of VRS

The novelty of VRS can have both positive and negative consequences. Most students express excitement about using new technology for learning; however, students unfamiliar with the technology may not fully engage in the learning process (Makransky, Borre-Gude, et al., 2019). In a quantitative survey to determine the motivational and cognitive benefits of immersive VRS training, Makransky, Borre-Gude, et al. (2019) reported that students' level of engagement was directly related to personal attitude and motivation. The authors concluded that the learner's emotional reaction to a VRS activity could significantly influence academic achievement. Indeed, personal attitude and motivation are factors that influence academic achievement for traditional classroom learning as well.

Makransky, Terkildsen, et al. (2019) performed quantitative research on 52 science students in the UK to determine whether higher levels of learning occurred with higher levels of VRS immersion. They used an electroencephalogram (EEG) to assess brain activity in students using different versions and discovered that VRS environments might be "overstimulating." They concluded that while students may enjoy the novelty of VRS activities, this did not necessarily equate to increased learning (Makransky, Terkildsen, et al., 2019). We must be mindful that introducing VRS into educational curricula, while entertaining, may not automatically lead to better learning outcomes. Since the sample size used in this study was relatively small, perhaps more research could help us understand how immersive VRS can be used in different educational contexts.

Monteiro and Sibbald (2020) postulate that the elements of surprise in the scenario are not essential to make simulation effective. They maintain that clear and transparent -based learning objectives will help learners focus on educational outcomes. "This focus optimizes learners' actions and reflections towards appreciation of the complexity of the educational outcome itself, rather than towards ferreting out the simulated surprise" (Monteiro & Sibbald, 2020, p. 514). In other words, while some situations may require an element of surprise, educational objectives must be considered when developing a compelling scenario.

Students cannot simply enter the VRS environment and intuitively understand the learning goals. Adeifila et al. (2020) noted that teachers must actively facilitate the process because learners present with different ontological perspectives of a valued learning experience. "Effective facilitation is, therefore, necessary to support the learning process and guide students away from clutching the traditional intellectual exercises they are accustomed to, towards a more reflexive, affective and participatory custom of learning with others" (Adefila et al., 2020, p. 59).

Several articles noted that debriefing and reflection are required to enhance learning with VRS. Feedback after the activity allows the learner to highlight and learn from mistakes and encourages self-reflection and critical analysis (Coyne et al., 2021; Reime et al., 2016). Students should be encouraged to engage in reflective practice; these skills help students analyze their performance and contemplate their mistakes, thus allowing them to examine their decision-making and draw conclusions to improve future practice. VRS appears to facilitate metacognitive thinking in learners. “In virtual nursing simulation, learners participate in a cycle of engagement and experience, which helps drive them toward greater learning achievement” (Shin et al., 2019, p. 10).

Training requirements for educators

Several articles noted that adequate training in VRS technology is essential for educators. In thematic interviews with eight educators, Keskitalo (2011) found that teachers required effort to become familiar with VRS technology and that subject expertise, planning, and flexibility were essential to ensure effective operation. Dieckmann et al. (2012) performed a qualitative study at the Danish Institute for Medical Simulation to determine process goals, success factors, and barriers in healthcare-

based courses. These researchers in Denmark interviewed seven educators to determine educator requirements. They found that training in facilitating scenarios and content expertise were essential to running successful activities. Each scenario design should have clearly defined learning objectives, and the instructor must be flexible in meeting the needs of individual learners (Dieckmann et al., 2012). These findings illustrate the important role of educators in the effective facilitation of VRS.

Training requirements for students

Students have identified that they require instruction and orientation before VRS to understand their role in the process (Peddle, 2019). A study by (Makransky, Borre-Gude, et al., 2019) found that students require an introduction to the control devices and VRS environment before use. Clear goals and objectives prior to use can assure that student expectations are realistic. Keskitalo (2012) examined student expectations of a VRS -based learning environment and discovered that students had high expectations for achieving the required learning outcomes. Students also expected knowledgeable and well-prepared instructors. This study analyzed student expectations before their experience, but their observations post VRS was not documented.

VRS educational applications

Various applications for VRS have been employed in healthcare education, including training in technical skills, communication, teamwork, professionalism, and interdisciplinary education. The literature provides evidence that VRS has been used successfully to develop technical skills. Students who prepared for laboratory sessions using VRS, followed by an in-class lab activity, were found to have increased self-efficacy and higher test scores (Makransky et al., 2016). Another study by Donkin et al. (2019) found that a blended learning approach with traditional hands-on experiences and VRS technology worked well. “Virtual or online learning experiences may be effective alternatives when the hands-on approach is too complex for early learners, expensive, or inaccessible due to laboratory constraints, or the activity is too time-consuming to complete in the laboratory” (Donkin et al., 2019. p. 10).

Research into the indirect measures of learning transfer between real and virtual environments has also led to valuable insight. Performance testing in a real-world

environment is not always feasible, so in an experiment designed to test mining personnel in evacuation procedures, a 3D simulation was used. Thus, the simulated setting can transfer knowledge to a real-world environment (Garrett & McMahon, 2013).

Another term used to describe VRS is “computer-supported collaborative learning” (CSCL). Nursing students who engaged in CSCL at a university in the UK noted improvement in their professionalism and communication skills, especially teamwork (Adefila et al., 2020). Peddle (2019) took a qualitative descriptive exploratory approach to identify student perceptions after engaging in VRS. She found that participants viewed VRS favorably for learning non-technical skills, including communication, teamwork, decision making, situational awareness, critical thinking, and problem-solving. Performing an activity, receiving feedback, and then repeating the exercise reinforced learning. Focusing on realistic and interactive scenarios helped learners engage in the activities and gain insight into real clinical situations (Peddle, 2019).

Interprofessional communication is another avenue for using VRS. Communication and collaboration between healthcare members are essential to providing quality patient care. Students who participated in interprofessional simulation identified a greater awareness of other health care members' roles and highlighted the contribution of each member. The students also found that this accentuated their understanding of teamwork after the experience (Williams et al., 2020).

In a review of 56 studies comparing traditional hands-on laboratory teaching to virtual laboratory teaching, Brinson (2015) analyzed various categories of learning outcomes (A summary of this data is presented in Table 1).

Table 1

Comparison of Traditional vs. Non-Traditional Learning

KIPPAS category	Traditional (TL) vs. Non-traditional teaching (NTL) learning outcomes
Knowledge and	equal or greater learning outcomes for NTL
Inquiry skills	inconclusive
Practical skills	equal or greater learning outcomes for TL
Perception	equal or greater learning outcomes for NTL
Analytical skills	inconclusive
Social and Scientific	inconclusive

Note: Adapted from "Learning outcome achievement in non-traditional (virtual and remote) versus traditional (hands-on) laboratories: A review of the empirical research" by J.R. Brinson.

There seems to be a lack of consensus supporting one method over another. The studies supporting higher achievement in NTL in the knowledge and understanding category used quizzes for assessment. The studies supporting higher achievement in TL used qualitative data related to student or instructor perception (Brinson, 2015).

Future areas for study

Shepherd and Burton (2019) cited a need to develop a conceptual framework to enable educators to devise a clear guide for implementation. They noted a lack of literature linking educational theories and learning models with simulation-based learning outcomes. Their research employed the "Modified Delphi technique," a group decision-making and forecasting method that involved successively collating experts' judgments.

VRS may also be an alternative to clinical hours. Recently challenges with staffing shortages and limited clinical spaces have emphasized this need. A National Council of State Boards of Nursing (NCSBN) study looked at replacing clinical hours with simulation. Nursing students from 10 prelicensure programs across the United States were randomized into one of three study groups: students with mainly traditional clinical experiences, students who had 25% of their traditional clinical hours replaced by simulation, and students who had 50% of their traditional clinical hours replaced by simulation(Hayden et al., n.d.). The study determined that high-quality experiences could replace up to half of the traditional clinical hours, with comparable end-of-program educational outcomes and new graduates ready for clinical practice. Given the current lack of clinical training sites in healthcare disciplines, this research is promising.

Future research into technological improvements may be a worthwhile pursuit. Current challenges with VRS technology, like visual discomfort and simulator sickness, have been noted (Bracq et al., 2019). The strengths and weaknesses of simulator design can lead to possible areas for improvement, like more instructional support for users and greater visual fidelity (Garrett & McMahon, 2013).

Perhaps the novelty of VRS may not stand the test of time. More research is needed to explore the long-term effects of a positive attitude towards VRS technology. “It is possible that the positive attitudes towards VRS training interventions that consistently appear in the literature could disappear over time” (Makransky et al., 2019, p. 702).

Research purpose and questions

This research project explored the perspectives of both educators and students in a post-secondary healthcare setting who had experienced VRS. Analysis of these experiences led to suggestions for improved instructor and student support and provided enhanced learning outcomes for students. Reviewing the barriers and successes of VRS helped to clarify the future role of VRS in healthcare at CNC.

Research Questions

1. What were the experiences of instructors and students who participated in VRS training as part of a college healthcare program?
2. What lessons were learned from instructors' and students' experiences that could improve future VRS curriculum development?

Analyzing the thoughts and experiences of educators and students who had taken part in VRS training helped to determine the future implications of VRS training by answering the following questions:

- What components are required to make VRS effective?
- What training was required for educators/students?
- What activities are best suited for VRS?
- What are the future recommendations for VRS at CNC?

Research Design

Methodology

Project Background

The VRS pilot project was initiated by the clinical mentor at CNC, who extended the invitation for nursing instructors and their students to participate. The site used for the VRS activity employed immersive VRS, where the participant wears a headset to perceive themselves in the simulated clinical setting rather than the physical world around them. The VRS site in Prince George hosted the sessions for CNC students and instructors free of charge. The VRS nursing scenarios were developed by Oxford Medical Simulation and offered as a free trial to educational institutes with the option to purchase. The scenarios were presented in a game-like format, where students could pass or fail depending on their actions.

Data collection

A qualitative evaluative approach was taken to understand teacher and student perspectives on using VRS in post-secondary healthcare education at CNC. Teacher perspectives were gathered via one-on-one semi-structured interviews, and student opinions were collected using information from focus group participation. O'Leary (2017) described evaluative research as gathering data to understand whether a particular initiative was worthwhile or whether it could be improved. The researcher aimed to evaluate the lessons learned from those who had used VRS and suggest improvements to enhance future practice.

Participants

Nursing instructors at the College of New Caledonia who participated in the VRS pilot project in the academic year 2020-21 were sent an email letter of invitation to partake in one-on-one interviews lasting approximately one hour (Appendix A). Invitations were sent to all CNC nursing faculty via the list serve, and three faculty members agreed to participate. Nursing students who attended CNC in 2021-21 who participated in the VRS pilot project were invited to participate in a focus group to share

their experiences with VRS while they were in their second year of study at the College of New Caledonia (Appendix B). Invitations were sent via the list serve to all nursing students, now in their third year, and four students agreed to participate. The invitation letters were sent out on the researcher's behalf by a third party, Dana Armstrong, the Administrative Assistant for the School of Health Sciences at CNC (Appendices C and D). Those participants expressing interest were sent consent forms (Appendices E and F). Interview and focus group questions were included in the consent form so that participants could preview the questions before consenting to become involved in the project (Appendices G and H). Any participants who responded directly to the third party were instructed to contact the researcher directly (Appendix I).

Theoretical Perspectives

As an instructor of a healthcare discipline at CNC, the researcher evaluated the lessons learned from instructors and students who used VRS. Taking an epistemological perspective that reality needs to be interpreted, the researcher used a constructivist approach to discern the perspectives of these groups (O'Leary, 2017). This methodology studied data through the eyes of the participants rather than the researcher. Examining the responses of instructors and students to interview questions provided evidence to make recommendations regarding the use of VRS technology in post-secondary healthcare education. Focus group questions were designed to evaluate students' opinions and understand their viewpoint on the role of VRS in post-secondary healthcare education. Interview questions for educators focused on their experiences and their opinions regarding the benefits and shortfalls of using VRS technology in healthcare curricula.

Ethical considerations

Ethics approval for this study was approved by both Simon Fraser University Research Ethics Board (REB) and the College of New Caledonia REB. Ethical concerns included a potential conflict of interest since the researcher was a faculty member at the College of New Caledonia. Faculty participants may have had concerns regarding their relationship with the researcher. Although the researcher had no connection with the nursing students, confidentiality concerns were addressed in the letter of invitation to

participate in the study. Participants were assured that involvement in the study was entirely voluntary and that no adverse consequences would occur if they decided not to partake. Confidentiality and anonymity were also assured in all invitational and consent form documents and any subsequent publications. The researcher offered a small token of appreciation to compensate participants for their time commitment in the form of a ten-dollar gift card.

Data Analysis

Data was collected from February 15, 2022, to March 30, 2022. Three one-on-one semi-structured interviews were completed with nursing instructors at the College of New Caledonia (CNC) online through the cloud-based video conferencing service "Zoom." The researcher conducted a focus group with four third-year nursing students from the University of Northern BC (UNBC) also online through Zoom. The researcher analyzed the qualitative data using broad predetermined codes based on interview and focus group questions. A subsequent review of the material led to emerging codes which were then sorted into categories. Categories were then broadened or collapsed into themes. A coding tree (Appendix J) is provided for reference.

The researcher discovered themes in the data to understand the information and generate understandings of the students and faculty experiences. The researcher believed that this type of qualitative inquiry must remain objective, methodical, and reliable, and participant responses must be correctly represented to establish an accurate account.

Findings

Through the iterative thematic analysis across the interview and sharing circle transcripts, the researcher identified six key themes: Participant motivation, attitude, and emotional state; VRS session preparation requirements; VRS learning activities; benefits of VRS; limitations of VRS; and participant recommendations for future implementation of VRS.

Participant motivation, attitude, and emotional state

The findings show that the research participants' motivation, attitude, and emotional state influenced their perception of VRS. Instructors were excited to promote a unique learning environment for students, and students, stirred by the instructors' enthusiasm, were curious about the activity.

The three nursing instructors interviewed had all worked as nursing professionals for at least ten years before becoming instructors at CNC. They were all relatively new to teaching, having approximately five years of experience. This analysis will refer to them as Casey, Darth, and Ember.

All three instructors were keen to participate in the VRS activity and felt it would be an excellent opportunity for their students. These instructors were passionate about providing an alternative learning environment for students and looked to VRS as a supplemental learning tool. Instructor Casey mentioned that not all nursing instructors took advantage of the opportunity since students were nearing the end of their clinical rotation and could not attend due to their schedules. Instructor Ember was excited to participate in VRS, noting, "I thought it would add another adjunct to my teaching methods to try and get [students] to think critically." Instructor Darth stated, "I've been a big advocate of simulation," and admitted to promoting the session to students.

The four students who participated in the focus group, now third-year nursing students at the University of Northern British Columbia (UNBC), were queried about their VRS experience as second-year nursing students at CNC. This analysis will refer to them as Fable, Grey, Hart, and Jet. Although they participated in VR under the directive of their instructor, they all agreed it seemed like it would be fun. Student Fable stated, "It

[VRS] actually got me really excited, and I was looking forward to it." Students explained that they appreciated the opportunity since they were nearing the end of their second year and were feeling very stressed and burned out. Student Grey added that the instructor's enthusiasm for the project was also a factor, "my entire clinical group was excited because my clinical instructor hyped it up." All students reported higher levels of enjoyment and engagement with VRS over conventional learning methods.

VRS session preparation requirements

Preparation for VRS appeared to be an individual undertaking. One of three instructors and two of four students had previous experience with VRS, and they indicated that they already felt comfortable with the technology. Students and instructors with no prior VRS experience required more time to familiarize themselves with the process.

Basic online tutorials were provided for instructors to prepare them for the experience. Each instructor approached preparation differently. Darth did not perform the online tutorials since they were already familiar with VRS technology, "I own a VR system, so I generally know how everything works." As for students new to VRS, Darth stated, "Younger people are so digital now, they can just figure it out." They explained how the staff at the VRS site were very knowledgeable and would be able to help students navigate through any technical issues. Casey completed the tutorials and found them somewhat cumbersome, "I remember it wasn't very intuitive, so I did spend quite a long time trying to set up user accounts [for students]." They also felt that the differences between student and instructor accounts were not well explained, leading to some confusion. Ember was able to take advantage of a practice session for a few hours at the VRS site, "We had the opportunity as instructors to go in and use the tech first to try and get a feel for it and figure out what we were teaching our students." Ember then took the information from the practice session to prime students for their own experience, assigning an online introduction before the session to optimize students' understanding.

Students described how they were given a basic ten-minute oral instruction just before the session by the site staff on using the VRS equipment. Two of four students stated that having previous VRS experience was advantageous. Student Hart explained, "I had previous VR experience, so I had a little background."

Darth maintained that the software was very intuitive and required only a minimal learning curve for today's tech-savvy students. Fable admitted that they initially struggled with the technology and needed some extra assistance at the start. "It felt like it took a couple of minutes, but once I got it, it started to make sense." Student Grey also initially struggled a bit with the gear and how to navigate the software.

VRS learning activities

The VRS session allowed students to practice nursing skills in a safe and realistic environment. Darth and the CNC clinical mentor viewed and chose the scenarios in advance, opting for ones that matched their learners' abilities. Nursing VRS scenarios focused on preparation for practice, situational awareness, and critical thinking. Darth indicated that the overall purpose of these scenarios was clinical decision-making.

Casey and Ember explained that their students spent approximately three hours at the VRS site, with a 45-minute practice session and two hours playing with scenarios. The first scenario run-through for students took longer to complete since students were still becoming familiar with the equipment. Subsequent sessions were completed faster, but typically most students could only practice two of the six scenarios in three hours. Eight groups of two students each were assigned to a virtual room with a clinical patient encounter. Darth described how one student would be wearing the headset and navigating the 3-dimensional environment while the second student could view the 2-dimensional situation via a companion screen.

Ember listed the six scenarios to trial that were available for nursing students at the second-year level: anaphylaxis, seizure and hypoglycemia, morphine overdose, chronic pain and drug-seeking behaviour, and urosepsis with delirium.

Each scenario came with a detailed case history of the patient and a list of learning objectives for the students to accomplish. Darth described the scenario involving sepsis, where the order the steps are performed is essential. The learner would enter a room with the patient, be expected to ask the patient questions, perform vital signs, and perform a basic physical examination. There would be options to order bloodwork, insert an IV to administer fluids and drugs, and perform SBAR (situation,

background, assessment, recommendation), a tool to communicate with the physician to determine the next steps.

Students explained that they could choose which scenarios they wished to practice. Grey mentioned that the order of steps was a factor in how well they performed "I was just going in the order that made the most sense to me, but sometimes the simulation didn't agree with that." Hart explained, "If you did PERRLA (pupils, equal, round, reactive to, light, accommodation) before you did vital signs, then that would be a mark against you." Grey stated that with subsequent run-throughs of each scenario, they could improve their score because they were learning what the game was expecting.

Benefits of VRS

Overall, instructors and students reported that the VRS session was valuable for engaging in critical thinking. Critical thinking refers to the ability to use an objective assessment of a situation to form a reasonable conclusion.

Darth found it to be "incredibly engaging and relevant when it comes to clinical decision-making." When asked to comment on the benefits of using VRS in healthcare education, Darth commented, "[VRS is] unparalleled for real clinical decision making when it comes to prioritizing decisions and getting some real feedback." Darth described how the "client" or patient is very convincing, with the ability to look scared or change their voice inflections, "You cannot get that level of realism with that [level of] clinical decision making in any other situation I can think of besides real practice."

Students agreed that VRS helped them with critical thinking. Hart stated, "I found that [VRS] helped me more with those critical thinking skills because, in year two, you are still working on that [ability]." Fable commented, "I had to use previous knowledge to critically work through a situation independently, without support." Hart added, "You could practice and see different outcomes without hurting anyone because it was a very safe learning environment."

Students all agreed that they enjoyed the experience so much that they did not recognize that learning had occurred. Grey commented, "In the moment, I thought that it was fun, but it wasn't until later that I realized, wow, that was beneficial!" The recollection of details of their VRS experiences a year after the session was still vivid in students'

minds. They revealed that it gave them the confidence to challenge themselves to act independently as nurses for the first time. "[VRS] provided autonomy, transparency, and emotional safety" (Hart). Grey added, "I didn't realize how much it helped me."

Casey felt that VRS worked well for tactile-based learners since the body movements of picking up and manipulating items helped consolidate learning, "I do think the hands-on really does benefit them [students]." Ember thought that VRS helped students get a broader perspective on the nursing role because they typically learn tasks separately, and VRS allowed them to work through all the tasks independently as a nurse would. They noted that students felt they gained a new perspective of their nursing role with repeated attempts at the scenarios.

Participants commented that the reflective piece after each scenario run-through was instrumental. Darth explained how the game feedback was essential to consolidate learning, "the game tells you where you went wrong so that you can make corrections in real-time." They affirmed that post-game reflection ensured that students understood what they did well and what areas needed improvement. Jet agreed, stating, "Afterwards, even if you didn't succeed, our instructor was happy to walk us through our scenarios if we had issues." Students felt that instructor feedback right after the session was essential to help solidify nursing practices. Hart explained that post-scenario discussions clarified the rationale behind the procedures, and conversations about which steps in the process were interchangeable helped students with their clinical reasoning. Casey described a post-scenario debrief, "When things didn't go right, they [the students] were able to talk it through; there were lots of giggles about things that didn't go right."

Limitations of VRS

Darth felt that students with motion sensitivity or epilepsy might find VRS unpleasant. Students mentioned that while they did not experience nausea during the sessions, several other students did. They also found the headsets to be heavy and uncomfortable. Grey described the headsets as one size fits all, "with a dial on the front, so you could adjust the eye spacing and a strap on the back to adjust how tight it was to your head, and that was about it." Jet had difficulty with headset fit while wearing prescription glasses and stated, "My face hurt from the glasses!"

Darth stated that because the scenarios were developed in the US, this led to some incongruencies with Canadian units of measurement, common tables, and lab values. Fable found the American content of the scenarios frustrating, "I feel like we have more autonomy in our practice as healthcare workers in Canada." Hart commented that more Canadian-related content, applicable to the British Columbia College of Nurses and Midwives (BCCNM) or the Canadian Nurses Association (CNA), would have made the scenarios more realistic. They believed that scenarios with Canadianized content would significantly improve the VRS experience.

Casey thought the barrier to using VRS was access. The college does not currently have this type of technology, so students cannot readily access it. They stated, "Even if we get some [VRS headset and controllers] for the lab, we all know how challenging lab time is."

According to Ember, the cost is a significant factor for students using VRS outside of school, "For students to be able to go back and use it again or use it as a study tool, they would have to pay for each session, and we all know that students don't have a lot of extra money."

Students also cited cost as a factor in VRS use. They spoke about how they paid an additional fee for a package of online simulations involving case studies in the third year. Grey stated, "It's a package we buy for around $200." Students unanimously preferred their VRS experience to the online case study simulations. Fable said, "The school makes us buy online sims for our laptops. We spend so many hours on our laptop as it is that I would go in and pay for VR sims any day!" Grey agreed, "Honestly, I found the in-person V sim way better than on the computer!"

Familiarity with VRS may prove advantageous for some learners initially; however, it does not necessarily indicate deeper learning of the subject matter. Casey noted that they had a particular student who was very familiar with VRS technology, and even though they scored highest in the game, they struggled in the nursing program. Casey felt that this student did well due to comfort with VRS rather than the nursing application. Given more exposure to VRS over time, Casey believed that all students would reach the same level of comfort with the technology and that the scoring would more accurately reflect the understanding of nursing concepts.

Participant recommendations for future implementation of VRS

Instructor research participants indicated that personal motivation and positive emotions influence whether other instructors would embrace VRS. Ember mentioned other instructors might be reluctant to embrace VRS since they are uncomfortable with advancing technology and are resistant to change.

Ember recommended collaboration with colleagues as an excellent way to promote VRS. They would urge all instructors to have an open mind and consider their learner's different learning styles since not all learners thrive in a strictly lecture-based environment. To understand what VRS is about, Darth said they would encourage instructors to try it out for themselves first, to run through the scenarios to understand what the student would experience. Darth stressed that VRS should be considered a supplemental teaching tool but has excellent potential for those who embrace it. Casey felt that more than just a basic written tutorial was required; they recommended a video tutorial to explain the instructor's role more explicitly. They stated, "any time there's a new technology, there is a learning curve, so I think walking people through it step by step would have been beneficial." Ember suggested that all nursing instructors partake in a 45-minute practice session involving an introduction to the scenario, the learning expectations, and practicing how to navigate the virtual world.

When asked what recommendations were required to support students using VRS, all instructors agreed that preparing the students in advance of the session with basic instructions and expectations was necessary. Darth mentioned that learners required at least minimum computer skills to navigate the VRS software. While all students felt adequately prepared for the session, Hart suggested that students be forewarned about the potential for nausea and motion sensitivity prior to arriving at the VRS site. Overall, students felt that the issue of motion sensitivity should not be a deterrent for potential students contemplating VRS. Fable joked, "Take a Gravol and move on; you're a nursing student!" Jet recommended that students wear contact lenses to fit the headset comfortably.

Darth would love to see the college invest in VRS technology, where an entire course could be taught through this medium, "If you saw it through a bit of a lens of the

future, you would see the potential implications for your own program." They added, "For me, it has a huge part to play in the future of education." They envision the college purchasing a powerful enough system to host VRS, suggesting that buying headsets with lower resolution might be an option to reduce cost. High resolution, according to Darth, is only required for graphically intense gaming, while less powerful, less expensive units would be adequate for simulating healthcare scenarios. Darth suggested that the content of virtual simulation scenarios should change and evolve depending on difficulty levels and clinical needs; thus, VRS can support students' lifelong learning.

Fable suggested that the college should support VRS and, rather than having students pay for online case studies, should provide four to six free VRS sessions instead. They said, "I found more value in the VR session, hands down, versus me sitting down at my laptop and doing it." Ember agreed that VRS would be a tremendous asset for the college, stating, "it would be very helpful to be able to introduce those critical thinking pieces tangibly before they get into the clinical setting."

All instructors agreed that VRS is an effective tool for supplemental learning; however, Casey asserted that other simulation products do a similar job (as VRS) and are less costly. For example, Casey used various online simulation case study scenarios when students missed classes due to illness. "I've found some really good online simulations I assign them to work through, and I get them to journal about what they learned." They felt that VRS should not be the only format considered when using simulation in healthcare education.

All participants agreed that VRS should be used for practice rather than for assessing student grades. Students felt that assessment would detract from the learning experience. Fable stated, "I enjoyed it because it wasn't punitive." They added, "I would have had anxiety getting worked up over these scenarios, and it wouldn't have been the same." Grey felt that it would have been hard to succeed in an environment where you don't really know what you're doing. Jet agreed that VRS allowed them to participate in a realistic experience without the academic responsibility. Ember cautioned that it would be unfeasible to grade students because instructor competence with the technology has yet to be established. They noted that grading created unnecessary anxiety in students and emphasized that they would repeatedly reiterate to students that the experience

would not be graded. Darth recommended clarifying the expectations and learning goals to students in advance to avoid confusion.

Discussion

The pedagogical use of VRS was a new and exciting technique introduced at CNC in healthcare education. This study aimed to understand what lessons could be learned from instructors and students who used VRS. The researcher used a constructivist approach to determine the experiences of nursing instructors and students who had used VRS. The researcher analyzed the data with the epistemological view that knowledge is interpreted by human perception and social experience.

Sound evidence is required to make effective education design decisions (Monteiro & Sibbald, 2020). Therefore, student and instructor perspectives contributed to a broader understanding of the benefits and shortfalls of this technology. Student learning in VRS was interactive, engaging, and contained realistic scenarios relevant to practice. Listening to their experiences provided valuable insights into what worked well and what needed improvement. Interviews with educators helped to identify what skills are required for teaching. Successfully integrating VRS into the curriculum depends on many factors. This study investigated various aspects involved to make suggestions for future VRS curriculum development at CNC. The fact that the researcher had no previous experience with VRS minimized potential bias.

The findings of this study correlate with the existing literature regarding the role of VRS in healthcare education. According to Akaike et al. (2012), the driving force for simulation-based education is the desire for patient safety and quality of care. VRS can replicate clinical situations by encouraging student cognitive, motor, and critical thinking development. The overall purpose of the VRS nursing scenarios was clinical reasoning and decision-making. The main benefit of the VRS session was encouraging students to think critically through repetition of practice in a safe and realistic environment. The VRS sessions reproduced actual patient scenarios with a high level of physical, environmental, and psychological realism. With repeated attempts at the scenarios, students could learn from their mistakes and improve their performance. Post scenario reflection required the learner to critically analyze their actions and develop a deeper understanding of the situation. "Virtual simulation supports students and healthcare workers to practice in a realistic and risk-free environment, as well as enhance the flexibility and autonomous learning" (Coyne et al., 2021).

The findings also support the existing literature regarding the metacognitive benefits of using VRS in post-secondary nursing healthcare education. However, it is essential to recognize that this study only illustrates participants' views of VRS after an initial trial. Shin et al. (2019) noted that "further research on the relationship between virtual simulation and metacognition is required."

Instructor motivational factors for using VRS included a desire to expose students to new and innovative learning techniques. Instructor enthusiasm was apparent, with all instructors highly motivated to offer their students alternative ways of learning. These findings correlate with Dieckmann et al. (2012), where instructors' personal and positive emotions were relevant for simulation-based education. Lack of experience with newer technologies may prevent some instructors from using VRS, leading to missed student engagement and learning opportunities. "Educators need self-reflection and professionalism to facilitate the use of learning opportunities by their course participants" (Kolb & Kolb, 2009, as cited in Dieckmann et al., 2012).

Students' attitudes and emotional states factored into their VRS experience; they found the option novel and exciting. These findings align with a quantitative study done by Bracq et al. (2019), where participants emphasized the pedagogical interest, fun, and realism of the VR simulator, and research done by Makransky, Borre-Gude, et al., (2019), reported that students' level of engagement was directly related to personal attitude and motivation. Adefila et al. (2020) identified four motivational aspects that facilitate learning in VRS: curiosity, challenge, confidence, and control. All students in this study identified these traits as contributing to their positive experience with VRS. Students' perspectives added credibility to the existing literature that VRS is a novel approach to teaching students.

Additionally, students' technical aptitude influenced the positive perception of VRS since basic competence with the technology is required for an optimum experience. Students familiar with VRS did not appear to have an advantage over those with no experience since learners required only minimal practice to navigate the scenarios successfully. The mean age of the student participants was less than 30 years, and it is unknown whether older adults would perceive VRS in the same favorable light. Hudson et al. (2015,as cited in Coyne et al., 2021), found that the older the student age, the lower the student's perceived usability of the simulation. This finding is supported by

another study by Makransky and Lilleholt (2018) as cited by Makransky, Borre-Gude et al., 2019) “Being unfamiliar with the technology can have negative consequences for learning because of the novelty of the interaction and unfamiliarity with control devices. Conversely, novelty can also have positive effects as students express excitement about using a new technology” (p. 701)

Students preferred the VRS session over the online case scenarios currently offered because they found VRS a more engaging learning environment. The non-punitive aspect of the event allowed the students to enjoy the experience without the fear of being graded. Coyne et al. (2021) recommend that "when using virtual simulation for assessment, it is important to ensure the instructor is competent with the technology and the technology is reliable" (p. 9). The timing of the session was a factor in students' favorable responses to the VRS session. Students were nearing the end of their second clinical rotation and described symptoms of fatigue and burn-out. They welcomed the opportunity for an innovative yet non-graded learning experience.

Cost and accessibility were significant considerations for utilizing VRS in healthcare education. VRS requires specific software, hardware, and equipment to operate. Incorporating affordable VRS programming in college healthcare curriculums may prove challenging; however, investment in VRS technology provides students with clinical practice learning opportunities in a safe environment. The repeatability of scenarios helped solidify learning for students; therefore, student accessibility to VRS is essential. "The analysis of the studies highlighted that the development of virtual simulation was cost-effective, and once developed could be used repeatedly and changed according to student need" (Borg Sapiano et al., 2018 as cited by Coyne et al., 2021, p. 7).

An unexpected finding of the study is the apparent gap in the literature regarding the VRS scenarios' cultural and educational content. Canadian content for scenarios was essential to ensure students were learning relevant material. Slight differences in practice between the US and Canada led to frustration for students and instructors. The BCCNM and CNA allow nurses more autonomy in clinical decision-making in Canada, making the VRS scenarios slightly out of sync with Canadian nursing practices. American units of measure and laboratory values are also significantly different than in Canada.

Recommendations

While VRS can be a valuable supplemental tool for assisting students in developing clinical reasoning skills, several factors must be considered.

An in-depth video tutorial on using the VRS equipment and navigating the scenarios is necessary for new users to grasp the system's complexities. Motion sensitivity must be addressed in advance of sessions to prepare students for potential adverse reactions.

Continuing college faculty education should focus on the educational value of VRS as an alternative learning system. Assistance with evaluating VRS scenarios for learning objectives and clinical relevance would improve the faculty's understanding of the potential learning opportunities. A focus on training instructors to acquire the skills needed to prepare and facilitate simulation sessions successfully would improve simulation outcomes. Consideration should also be given to requirements for supporting students. Additionally, administrative support may be required to integrate simulation into the existing curriculum.

Activities suited for VRS involve scenarios that require clinical decision-making, with allowances for repeatability to ensure learning objectives are met. Ideally, VRS scenarios must represent Canadian content to ensure relevance and authenticity. Adapting and modifying scenarios as learners increase proficiency creates additional learning opportunities. According to research by Coyne et al. (2021), virtual simulation scenarios were considered more beneficial if they could be customized to the learner and the aim of the teaching session. Technology that enables multiple user synonymous interaction could be used for teamwork and communication exercises. "In an era where the preparation of healthcare professionals increasingly requires inter-professional learning, virtual simulation needs to evolve to include more interdisciplinary interaction among participants." (Coyne et al., 2021, p. 8)

Post-secondary institutions should undertake a cost-benefit analysis to determine the feasibility of implementing VRS in healthcare curriculums. Consideration should also be given to the frequency of access for students since the ability to repeat sessions to consolidate learning is essential.

Future research

The relatively small sample sizes made it hard to determine the full extent of the potential role of VRS in education. The researcher would like to review the quantitative data collected by the CNC clinical mentor after the VRS pilot project and correlate findings with this study to provide more insight into the benefits and limitations of VRS in post-secondary healthcare education.

This study did not explore the possible pedagogical differences across disciplines, so it is difficult to determine if VRS suits other healthcare disciplines. Future research should include an investigation of the practicality of VRS for other healthcare disciplines. This research should be focused on learning outcomes to provide convincing evidence to determine the effectiveness of VRS-based education across healthcare disciplines.

Since VRS is just one aspect that falls under the simulation umbrella, additional research avenues could include comparing the effectiveness of various types of simulation in healthcare education. Simulation is a method that recreates aspects of actual clinical situations, and it consists of multiple techniques that facilitate student learning, including laboratory sessions, computerized activities, and human interactions.

Recent healthcare staffing shortages have led to challenges with providing students access to clinical training sites. Simulation can mimic situations in the clinical setting for students to learn the technical skills and competency required for health care. Research should explore whether simulation can effectively reduce some clinical experience hours and workload at clinical sites.

Conclusion

This study aimed to discern the perspectives of both instructors and students to determine the benefits and limitations of VRS for post-secondary healthcare education. Feedback from instructors and students indicated that VRS could be an effective supplemental tool for encouraging critical thinking. VRS can aid in preparing students for the clinical environment by providing a safe and realistic environment. The value of VRS-based learning is enhanced by post-scenario reflection. As well, allowing the learner to repeat scenarios reinforced learning. Cost, accessibility, and relevance must be considered when implementing clinical simulation opportunities for practice.

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Appendix A.

Faculty letter of invitation to participate in an interview

VIRTUAL REALITY SIMULATION IN HEALTHCARE EDUCATION: WHAT LESSONS CAN WE LEARN?

Principal Investigator: Dr. Michelle Pidgeon, Academic Supervisor, SFU

Student Lead: Claire Hicks, MEd Candidate

Purpose:

The purpose of this study is to explore the perspectives of both students and faculty in a post-secondary healthcare setting who have experienced Virtual Reality (VR) Simulation.

You have been invited to participate in this study as a nursing faculty member at the College of New Caledonia (CNC). As an instructor in the Medical Laboratory Technology Science Program, I would like to learn about your experiences with Virtual Reality Simulation while teaching at CNC in the 2020-21 academic year. Your experiences can help to inform me about the benefits and barriers to Virtual Reality/simulation in education. I am focused on learning about what components make VR simulation effective, what training is required for educators and students, and what educational applications work well with this technology. This research will help to clarify the future role of VR simulation in healthcare at CNC and provide better support for educators and enhanced learning outcomes for students. The findings of this project will be used in partial requirements for the completion of my Master of Educational Leadership. The final report and results will be presented during the 2022 Summer Institute, other conferences, and publication opportunities.

Study Procedures:

You are being invited to participate in this study, involving a **one-on-one, semi-structured interview** with me in Zoom. This interview would take approximately 45-60 minutes of your time.

I will ask you to talk about your experience with VR simulation, particularly if you experienced any benefits or barriers to learning using this technology. I am also curious about whether you found value in the session and whether you have any recommendations for improvement. Participants will have the opportunity to preview the

specific questions prior to the session.

Participation in this project is entirely voluntary, and it will be scheduled at a time that is convenient for you. You have the right not to answer any question and to withdraw from the project at any time.

This is a **minimal risk study**. The stress involved in participating will be no more than the stress that you encounter in your daily work.

Remuneration/Compensation. A ten-dollar e-gift card will be emailed to you as a small gift of appreciation for participating in this study.

Contact for interest in participating in the study. If you are interested in participating, please contact Claire Hicks.

I will follow up to discuss this matter with you directly, either by email or phone.

Contact for information about the study. If you have any questions about this project, please contact me. You may also contact Dr. Michelle Pidgeon, Faculty of Education.

Contact for concerns about the study. If you have any concerns about your rights or treatment as a research participant, please contact SFU Office of Research Ethics.

Many thanks for your assistance,

Claire Hicks
MEd candidate
Simon Fraser University

Appendix B.

Student letter of invitation to participate in a focus group

VIRTUAL REALITY SIMULATION IN HEALTHCARE EDUCATION: WHAT LESSONS CAN WE LEARN?

Principal Investigator: Dr. Michelle Pidgeon, Academic Supervisor, SFU

Student Lead: Claire Hicks, MEd Candidate

Purpose:

The purpose of this study is to explore the perspectives of both students and faculty in a post-secondary healthcare setting who have experienced Virtual Reality (VR) Simulation.

You have been invited to participate in this study in your role as a second nursing student at the College of New Caledonia (CNC) in the 2020-21 academic year. As an instructor in the Medical Laboratory Technology Science Program, I am interested in learning about the benefits and barriers to Virtual Reality (VR) Simulation. I am focused on learning about what components make VR simulation effective, what training is required for educators and students, and what educational applications work well with this technology. This research will help to clarify the future role of VR simulation in healthcare at CNC and provide better support for educators and enhanced learning outcomes for students. The findings of this project will be used in partial requirements for the completion of my Master of Educational Leadership. The final report and results will be presented during the 2022 Summer Institute, other conferences, and publication opportunities.

Study Procedures:

You are being invited to participate in this study, which would involve being part of a **focus group** with fellow participants, who are also former/current students.The focus group would take place in Zoom and last approximately 60-120 minutes.

I will ask you to talk about your experience with VR simulation, particularly if you experienced any benefits or barriers to learning using this technology. I am also curious about whether you found value in the session and whether you have any recommendations for improvement. Participants will have the opportunity to preview the specific questions prior to the session.

Participation in this project is entirely voluntary, and it will be scheduled at a time that is convenient for you. You have the right not to answer any question and to withdraw from the project at any time.

This is a **minimal risk study**. The stress involved in participating will be no more than the stress that you encounter in your daily work.

Remuneration/Compensation. A ten-dollar e-gift card will be emailed to you as a small gift of appreciation for participating in this study.

Contact for interest in participating in the study. If you are interested in participating, please contact Claire Hicks.

I will follow up to discuss this matter with you directly, either by email or phone.

Contact for information about the study. If you have any questions about this project, please contact me. You may also contact Dr. Michelle Pidgeon, Faculty of Education.

Contact for concerns about the study. If you have any concerns about your rights or treatment as a research participant, please contact SFU Office of Research Ethics via email.

Many thanks for your assistance,

Claire Hicks
MEd candidate
Simon Fraser University

Appendix C.

Third party consent form

July 20, 2021

Re: Research proposal ***Virtual Reality Simulation in Post Secondary Healthcare Education: What lessons can we learn?***

I _____Dana Armstrong_____ consent to act as a third party to contact research participants on behalf of Claire Hicks, MEd Candidate, Faculty of Education, SFU.

I agree to send initial email invitations and follow-up reminders, as directed by Claire Hicks, for the purpose of recruiting participants for this research study. Invitations will be sent to instructors and nursing students who participated in Virtual Reality Simulation at CNC during the 2020-21 academic year. The purpose of this study is to explore the perspectives of both students and faculty in a post-secondary healthcare setting who have experienced Virtual Reality (VR) Simulation.

Sincerely,

College of New Caledonia
CNC

Dana Armstrong BSc

Acting Admin Assistant

Appendix D.

Third party email script

VIRTUAL REALITY SIMULATION IN HEALTHCARE EDUCATION: WHAT LESSONS CAN WE LEARN?

Greetings,

This email is an introduction and invitation to participate in a research study.

I am a third person collaborator forwarding this invitation on behalf of Claire Hicks, who is a CNC faculty member. Claire is doing this study as part of completing a Master of EducationalLeadership through SFU.

You are receiving this invitation because you have participated in VR Simulation at CNC in the 2020-21 academic year. Please read the attached letter of invitation for a detailed description ofthis study.

If you are interested in participating or have questions about the study, please contact ClaireHicks for more information.

Thank you,

Dana Armstrong, BSc
Acting Admin Assistant, CNC

Appendix E.

Informed consent to participate in an interview

VIRTUAL REALITY SIMULATION IN HEALTHCARE EDUCATION: WHAT LESSONS CAN WE LEARN?

Thank you for considering participating in an interview about virtual reality simulation in healthcare education. Before you decide whether to participate, please take time to review the following information. If you have any questions or need additional information, please ask! If, after reviewing this information, you are still interested in participating, then we will go forward with the interview.

As the student lead, I, Claire Hicks, am conducting this focus group as part of a research project exploring what components make VR simulation effective, what training is required for educators and students, and what educational applications work well with this technology. I am an instructor in the Medical Laboratory Technology Program at the College of New Caledonia. This project is a requirement for the Master's in Educational Leadership program at SFU. This research is being supervised by my principal investigator, Dr. Michelle Pidgeon, Faculty of Education.

The purpose of this research is to learn more about the lessons learned from those who have experienced VR simulation in healthcare education. You have been invited because you are a faculty member at CNC who has experienced VR simulation in healthcare education. If you choose to participate, I will meet with you in Zoom for a 45-60 minute conversation to explore your perspectives on the virtual reality experience. I will ask you to talk about your experience with VR simulation, particularly if you experienced any benefits or barriers to learning using this technology. I am also curious about whether you found value in the session and whether you have any recommendations for improvement. You may choose not to answer any of my questions, and you may also end your participation in the interview at any point during the scheduled time. I will ask the following questions during the interview, and there may be other questions generated during our conversation:

1. Can you tell me a little bit about your background as a nursing instructor at CNC?
2. How did you become involved in the pilot project using VR simulation at CNC?
3. How did you prepare for the session?
4. What elements of VR simulation did you find beneficial for student learning?
    - What worked well?
5. What elements of VR simulation did you find a barrier for student learning?
    - What didn't work well?
6. Did you find value in the VR session?
7. What recommendations would you make to support instructors using VR technology?
8. What recommendations would you make to support students using VR technology?

This is a **minimal risk study**. The stress involved in the interview conversation will be no more than the stress that you encounter in your daily work. Also, I will be keeping everyone's identity confidential to reduce risk.

This interview is hosted by Zoom, a US company. Any data you provide may be transmitted and stored in countries outside of Canada, as well as in Canada. It is important to remember that privacy laws vary in different countries and may not be the same as in Canada.

Any information you share during this interview **will remain confidential**. I will ask you to choose a pseudonym for use in the research study. I will transcribe the interview myself, using that pseudonym, and the resulting transcript will not include any information that could be traced back to you. Audio-video recordings, transcripts, and other information related to this research study will be kept on a **password protected** personal computer. The list matching participant information and pseudonyms will be stored separately on a USB stick and stored in a locked filing cabinet in my office. The deadline for withdrawal of your information from the study is April 30, 2022. I will destroy the audio-video recordings at the completion of the research project in May of 2022. Transcripts will be maintained for use for future publications and will be destroyed after five years.

After I complete all my MEd degree requirements, I will present the results of this research in the form of a written report to my faculty supervisor and a public poster session at the 2022 Summer Institute at CNC and SFU.

Participation in this research is voluntary. Please do not feel any pressure to participate because of an existing relationship with a member of the research team. You can decide to stop participating at any point in the process for any reason. Your decision to participate (or not) will not be shared with anyone. There are no negative consequences for withdrawing your participation, and I will erase/destroy any information already collected from you.

If you would like to talk to my principal investigator, you can reach Dr. Michelle Pidgeon.

If you have any concerns about your rights as a research participant and/or your experiences while participating in this study, please contact SFU Office of Research Ethics.

Signing this consent form indicates that:
You agree that this interview can be recorded for transcription purposes.
You agree to participate in this research and to having the interview audio-video recorded. You understand that you are free to stop participating in this research at any time.
You acknowledge that a $10 e-gift card will be sent to you by email for your participation.

Signature of Participant Date
(MM/DD/YYYY)

Printed Name of Participant

Appendix F.

Informed consent to participate in a focus group

VIRTUAL REALITY SIMULATION IN POST-SECONDARY HEALTHCARE EDUCATION: WHAT LESSONS CAN WE LEARN?

Thank you for considering participating in a focus group about virtual reality simulation in healthcare education. Before you decide whether to participate, please take time to review the following information. If you have any questions or need additional information, please ask! If, after reviewing this information, you are still interested in participating, then we will go forward with the focus group.

As the student lead, I, Claire Hicks, am conducting this focus group as part of a research project exploring what components make VR simulation effective, what training is required for educators and students, and what educational applications work well with this technology. I am an instructor in the Medical Laboratory Technology Program at the College of New Caledonia. This project is a requirement for the Master's in Educational Leadership program at SFU. This research is being supervised by my principal investigator, Dr. Michelle Pidgeon, Faculty of Education.

The purpose of this research is to learn more about the lessons learned from those who have experienced VR simulation in healthcare education. If you choose to participate, I will meet with you and 8-12 other focus group participants through Zoom for a 60-120 minute group conversation to explore your perspectives on the virtual reality experience. I will ask you to talk about your experience with VR simulation, particularly if you experienced any benefits or barriers to learning using this technology. I am also curious about whether you found value in the session and whether you have any recommendations for improvement. You may choose not to answer any of my questions, and you may also end your participation in the focus group at any point during the scheduled time. I will ask the following questions during the focus group, and there may be other questions generated during our conversation:

1. How did you prepare for the VR session?
2. What was the learning objective of this activity?
3. What elements of VR simulation did you find beneficial for student learning?
    - What worked well?
4. What elements of VR simulation did you find a barrier for student learning?
    - What didn't work well?
5. Did you find value in the VR session?
6. What recommendations would you make to improve the VR experience?
7. What recommendations would you make to support students using VR technology?

This interview is hosted by Zoom, a US company. Any data you provide may be transmitted and stored in countries outside of Canada, as well as in Canada. It is important to remember that privacy laws vary in different countries and may not be the same as in Canada.

This is a **minimal risk study**. The stress involved in the focus group conversation will be no more than the stress that you encounter in your daily work. Also, I will be keeping everyone's identity confidential to reduce risk. This means that you will be known to the other members of the focus group, but I will not release your name or describe your participation in the focus group in such a way that you could be identified.

Any information you share during this focus group **will remain confidential**. All focus group members will be asked not to share any focus group conversations with external audiences. I will ask you to choose a pseudonym for use in the research study. I will transcribe the focus group myself, using that pseudonym, and the resulting transcript will not include any information that could be traced back to you. Audio-video recordings, transcripts, and other information related to this research study will be kept on a **password protected** personal computer. The list matching participant information and pseudonyms will be stored separately on a USB stick and stored in a locked filing cabinet in my office. The deadline for withdrawal of your information from the study is April 2022. I will destroy the audio-video recordings at the completion of the research project in May of 2022. Transcripts will be maintained for use for future publications and will be destroyed after five years.

After I complete all my MEd degree requirements, I will present the results of this research in the form of a written report to my faculty supervisor and a public poster session at the 2022 Summer Institute at CNC and SFU.

Participation in this research is voluntary. You can decide to stop participating at any point in the process for any reason. Your decision to participate (or not) will not be shared with anyone.

There are no negative consequences for withdrawing your participation, and I will erase/destroy any information already collected from you.

If you would like to talk to my principal investigator, you can reach Dr. Michelle Pidgeon. -

If you have any concerns about your rights as a research participant and/or your experiences while participating in this study, please contact SFU Office of Research Ethics.

Signing this consent form indicates that:
You agree that this interview can be recorded for transcription purposes.
You agree to participate in this research and to having the focus group audio-video recorded.
You understand that you are free to stop participating in this research at any time.
You acknowledge that a $10 e-gift card will be sent to you by email for your participation.

Signature of Participant Date (MM/DD/YYYY)

Printed Name of Participant

Appendix G.

Interview protocol

VIRTUAL REALITY SIMULATION IN POST-SECONDARY HEALTHCARE EDUCATION: WHAT LESSONS CAN WE LEARN?

Hello, my name is Claire Hicks. I am an instructor with the Medical Laboratory Technology program at CNC. Thank you for joining me today for an interview. The interview will take approximately 45-60 minutes and will consist of questions which deal with your experiences and perceptions of VR simulation. I want to remind you that anything discussed during the interview will be kept confidential. I will ask you to provide me with a pseudonym for use during the interview, so that the final report will not include any information that can be traced back to you.

Did you read and fully understand the consent form?

Did you sign the consent form and sent it to me?

Do I have your permission to record this interview?

What pseudonym would you like me to use for you?

Are you ready to begin?

The following questions will be included in the interview; however, further questions may emerge during the conversation.

1. Can you tell me a little bit about your background as an instructor at CNC?

2. How did you become involved in the pilot project using VR simulation at CNC?

3. How did you prepare for the session?

4. What elements of VR simulation did you find beneficial for student learning?

   - What worked well?

5. What elements of VR simulation did you find a barrier for student learning?

   - What didn't work well?

6. What recommendations would you make to support instructors using VR technology?

7. What recommendations would you make to support students using VR technology?

8. Did you find value in the VR session?

Thank you so much for participating in this interview. Your insights are invaluable! If you are interested, I will be presenting the results of this research in a public poster session at the 2022 Summer Institute at CNC and SFU.

Appendix H.

Focus group protocol

VIRTUAL REALITY SIMULATION IN POST-SECONDARY HEALTHCARE EDUCATION: WHAT LESSONS CAN WE LEARN?

Hello, my name is Claire Hicks. I am an instructor with the Medical Laboratory Technology program at CNC. Thank you for joining me today for a focus group. The focus group will take approximately 60-120 minutes and will consist of questions which deal with your experiences and perceptions of VR simulation. I want to remind you that anything discussed during this focus group will be kept confidential. Although you will be known to other members of the focus group, I ask that you do not to share any focus group conversations with external audiences.

I have received your signed consent forms to participate in the focus group. I will like to remind everyone that this interview will be recorded. Your confidentiality will be protected with the use of a pseudonym.

The following questions will be included in the focus group; however, further questions

may emerge during the conversation.

1. How did you prepare for the VR session?

2. What was the learning objective of this activity?

3. What elements of VR simulation did you find beneficial for student learning?

- What worked well?

4. What elements of VR simulation did you find a barrier for student learning?

- What didn't work well?

5. Did you find value in the VR session?

6. What recommendations would you make to improve the VR experience?

7. What recommendations would you make to support students using VR technology?

Thank you so much for participating in this focus group. Your insights are invaluable! If you are interested, I will be presenting the results of this research in a public poster session at the 2022 Summer Institute at CNC and SFU.

Appendix I.

Third party redirection script

VIRTUAL REALITY SIMULATION IN HEALTHCARE EDUCATION: WHAT LESSONS CAN WE LEARN?

Greetings,

Please note that this email has not been forwarded onto the researcher. In order to contact the researcher please use the email address listed below.

If you are interested in participating or have questions about the study, please contact Claire Hicks for more information.

Thank you,

Dana Armstrong, BSc
Acting Admin Assistant, CNC

Appendix J.

Data Analysis Coding Tree