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Implementing Immersive Virtual Reality into a Nursing Curriculum

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Abstract

Due to workforce demands, new undergraduate nurses are hired directly into fast-paced units and are expected to manage complex patients with rapidly changing conditions and respond to time-sensitive situations. It is important for nurse educators to prepare undergraduate nurses for transition into clinical practice upon graduation. Simulation has been a valuable tool to provide experiential learning and promote clinical decision-making. The next iteration of improving clinical simulation as an experiential learning modality for nursing students is Immersive Virtual Reality (IVR): a realistic, immersive simulation in a 3-dimensional environment that is experienced by body movements and hand controllers. IVR can incorporate the layers of the clinical judgment model including recognizing cues, analyzing cues, prioritizing hypotheses, generating solutions, taking action, and evaluating. The purpose of this study was to examine the use of IVR in a baccalaureate nursing program curriculum. A prospective, non-randomized study design was conducted at a midwestern academic medical center College of Nursing. A convenience sample of second-semester BSN nursing students (N=83) participating in an IVR clinical experience was included in this study. Statistically strong correlations were found between learning and engagement r (81) = .746, p < .001, and engagement and immersion r (81) =.517, p < .001. Moderate levels of correlation were found between learning and immersion r (81) = .466, p < .001, and learning and challenge r (81) = .389, p < .001. Incorporating IVR into a BSN curriculum is feasible and provides an engaging, flexible, learning environment. IVR provides a positive learning experience and overall students want to continue to use it in the future. Future research establishing best practices for IVR needs to be completed.

Key Words

Immersive Virtual Reality, Simulation, Innovation, Clinical Judgment, Clinical Reasoning

Due to workforce demands, new undergraduate nurses are hired directly into fast-paced units and are expected to manage complex patients with rapidly changing conditions and respond to time-sensitive situations. The COVID-19 pandemic further heightened the need for a practice-ready nursing workforce to address the surge of patients and critical needs of patients (Russell & Juliff, 2021). A recent concept analysis of practice readiness further informs the needed preparation of undergraduate nurses (Mirza, Manankil-Rankin, Prentice & Hagerman, 2019). The study findings determined attributes of practice readiness include cognitive, professional, and clinical capabilities, as well as self-efficacy. New graduate nurses must be prepared to use sound clinical judgment and clinically reasoning in time-sensitive, complex situations.

Nursing educators are called to provide engaging and meaningful learning experiences to prepare students for transition to clinical practice. Nurse educators must strive to integrate new and innovative experiential learning to support practice readiness. The National Academy of Medicine in *The Future of Nursing 2020-2030* (2021) emphasizes the need for experiential learning. The use of simulation is currently recognized as a vital component of clinical nursing education (American

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Association of Colleges of Nursing Essentials, 2021). New graduates who had 25-50% of their nursing education that included simulation experiences were rated by their managers as having significantly (p<0.05) better clinical knowledge and critical thinking in comparison to a control group (Hayden et al., 2014).

The next iteration of clinical simulation as an experiential learning modality for nursing students is IVR. This provides a realistic, immersive simulation in a 3-dimensional environment that is experienced by body movements and hand controllers. The learner is transported into the IVR environment via a head-mounted apparatus that prevents perception of the surrounding elements of the real world (Sitterding, Raab, Saupe, & Israel, 2019). IVR can incorporate the layers of the clinical judgment model (NCSBN, 2019) including recognizing cues, analyzing cues, prioritizing hypotheses, generating solutions, taking action, and evaluating. The realism and authenticity of IVR further enhance the experience through engagement and experiential learning (Verkuyl & Hughes, 2019). As technology in practice and education advances, so must the education of a new generation of learners. Immersive virtual reality (IVR) is a new and innovative technology that has shown promise in educating nursing students. Educators must evaluate the feasibility of incorporating such technology into our curriculums to prepare student nurses for the workforce.

The additional experiential learning benefits of IVR include improving psychomotor skills, cognitive and affective thinking, as well as including content that can be reviewed at a time that is convenient for the learner. IVR allows for flexibility and scalability. It is more environmentally friendly than traditional simulation and can require less effort in simulation setup, coordination of resources, and expenses that are associated with hands-on simulation training (Chang & Lai, 2021; Ferguson et al., 2015; Gillespie et al., 2021; Liaw et al., 2019; McCarthy & Uppot, 2019; Shorey & Ng, 2021). IVR simulation used in nursing education has the potential to improve knowledge retention and clinical reasoning during the initial experience and continues to grow over time while increasing nursing students' satisfaction with the learning experience. (Chen et al., 2020; Fealy et al., 2019; Jallad & Isik, 2021; Padilha et al., 2019; Verkuyl et al., 2016). IVR has also been shown to increase self-confidence and decrease anxiety as measured by the Nursing Anxiety and Self-Confidence with Clinical Decision-Making Scale (Adhikari et al., 2021). Using virtual patients increased the nursing student's awareness of what to focus on during their clinical practice (Forsberg et al., 2016). Claman (2015) expanded the boundaries of virtual gaming and studied Multi-user Virtual World Environments (MUVEs). Participants using MUVEs had significantly higher engagement scores (M=3.61, SD-1.13) compared to the asynchronous learning platform (M=3.49, SD=1.08, t (1766) =2.21, p < 0.05). Future uses of virtual workspaces will allow designers and health care educators to work within the virtual world to provide improved quality scenarios and focus on interprofessional education (D'Errico, 2021).

The purpose of this study was to examine the use of IVR in a baccalaureate nursing program curriculum. Specific aims included: a) assess the feasibility of incorporating IVR in a prelicensure Bachelor of Science in Nursing (BSN) curriculum, b) examine student perceptions of the IVR experience, and c) explore the interrelationships between student learning, engagement, immersion, challenge, and skills developed.

Method

A prospective, non-randomized study design was conducted at a midwestern academic medical center college of nursing. A convenience sample of second-semester BSN students participating in an IVR clinical experience was used this study. The scenario that was selected for the students was a virtual COVID-19 patient. This type of patient was chosen given the need to prepare the graduate nurse to care for these patients with limited clinical experiences. Ninety students completed the IVR

and were invited to complete the post-simulation survey. The Institutional Review Board determined the study to be exempt. No individual demographic or identifiable participant data was collected in this study.

Participants were given the option to engage in tutorials on IVR and Oculus headsets loaded on their learning management system along with open labs to provide hands-on orientation in the weeks before the simulation. Hands-on orientation was offered to all participating students. Pre-simulation student assignments pertaining to COVID-19, pneumonia, and safety were required. Pre-briefing of the IVR clinical simulation experience was conducted and included "report" on the patients the students would be providing care for during the IVR simulation. Learning pairs completed two IVR simulations, one student used the Oculus headset while the second student moderated with the faculty member and completed a clinical judgment/QSEN (Quality and Safety Education for Nurses) worksheet, developed by the investigators, on the student within the IVR experience. Students changed roles and completed the second scenario. Student pairs returned to their large group (7-8 students) to debrief and discuss the experience using the PEARLS (Promoting Excellence and Reflective Learning in Simulation) debriefing model. Students were then invited to evaluate the IVR experience by completing an engagement tool delivered via an online survey immediately after debriefing. A QR code was provided for students to use if they chose to use their smartphones.

The International Nursing Association for Clinical Simulation and Learning (INACSL) healthcare standards were used throughout the simulation (INACSL 2022). Prework was handed in at the time of the simulation and used as an 'admission ticket to class'. Prebriefing included an explanation of the simulation, report given on the patient, and an explanation of the QSEN worksheet. The QSEN worksheet was completed by the observing student, who could observe the simulation on a screen that projected what the student in the headset did and saw. The worksheet also served as a reference for the student during debriefing. The PEARLS model was used for debriefing and during the analysis phase students discussed concepts from the worksheets, including assessments made and those not made, nursing diagnoses, worst complications, and how to prevent and treat these, as well as the students describing what actions they took that were patient-centered, evidence-based, and safety focused. The debriefing was rich and robust. Faculty who participated in the debriefing sessions took field notes after each session.

Instruments

Engagement Tool: A 19-item questionnaire with subscales of perceived learning, engagement, immersion, challenge, and skill was administered electronically. Hamari et al. (2016) developed and utilized the tool to measure students' experience in game-based learning and reported the tool to have acceptable convergent and discriminant validity and reliability. Questions were anchored with a 5-point Likert scale.

Student Input on Usage: Additional questions were used to query the students' perceptions. Specifically, students were asked if they wanted to participate in IVR as a learning modality in the future (5-point Likert Scale), if they had previous IVR experience (Y/N) if they attended the open lab orientation (Y/N), and if they had any physical symptoms (e.g., cybersickness, dizziness, nausea) from using the headsets and IVR, with an open comment section for students to provide types of symptoms experienced.

Data Analysis

Descriptive data analysis of the Engagement tool included descriptive statistical analysis for each of the constructs of learning, engagement, immersion, challenge, and skill related to the IVR simulation experience. Analysis of variance and Pearson correlations were used to assess differences in experience levels and constructs using SPSS Version 26.0 (IBM Corp., 2019). Levels of experience were coded as a) no experience, b) attended an orientation or had previous IVR experience, and c) attended orientation and IVR experience. Descriptive statistics were used to report student preferences on use.

Results

A total of 90 students were invited to participate in this study. All participants completed the course required IVR experience, and 83 completed post surveys, for a response rate of 92.2%. All students completed the objective and critical behaviors identified in the scenario, students were guided through the simulation, and Socratic questioning was used at times to assist in achieving the expected behaviors. Of the 83 participants, 25 had attended an orientation session, 29 had some type of previous IVR experience, and 36 had no experience or orientation in IVR. A one-way analysis of variance (ANOVA) showed no significant differences by effect of orientation and/or IVR experience on the outcomes of learning ($p=0.37$), engagement ($p=0.58$), immersion ($p=0.65$), or challenge ($p=0.95$), and skill ($p=0.07$) constructs.

There were statistically significant correlations between learning and engagement r (81) = .746, p < 0.001; and engagement and immersion r (81) =.517, p < 0.001. In addition, moderate levels of correlation were statistically significant between learning and immersion r (81) = .466, p < 0.001: and learning and challenge r (81) = .389, p < 0.001. There was no statistical interrelationship for skill with any of the other constructs. See Table 1.

Table 1 Subscale Correlations

Subscale Correlations

		Learning	Engage	Immersion	Challenge
Engage	Pearson Correlation	.746**			
	Sig. (2-tailed)	0.000			
	N	83			
Immersion	Pearson Correlation	.466**	.517**		
	Sig. (2-tailed)	0.000	0.000		
	N	83	83		
Challenge	Pearson Correlation	.389**	0.188	.325**	
	Sig. (2-tailed)	0.000	0.090	0.003	
	N	83	83	83	
Skill	Pearson Correlation	0.193	0.149	0.056	0.016
	Sig. (2-tailed)	0.081	0.180	0.616	0.884
	N	83	83	83	83

**. Correlation is significant at the 0.01 level (2-tailed).

Students reported a strong sense of perceived learning, increased understanding, and a desire to continue to use IVR as a learning modality. When asked "Did you feel you were learning?" 93% (M = 4.3) strongly agreed/agreed, while 88% (M = 4.3) strongly agreed/agreed that the simulation helped them learn, 83 % (M =4.2) strongly agreed/agreed that playing the simulation increased their understanding and 81% (M =4.2) strongly agreed/agreed that they wanted to continue to use VR as a learning modality.

The students were asked before using the headsets if they had any issues with motion sickness or vision issues, particularly colorblindness. One student with colorblindness had no problems with the IVR, and two students requested not to use the headsets based on a history of motion sickness. These students were able to monitor the laptop screen and direct the actions of a staff member assisting with the IVR. Twelve percent of the students did indicate on the survey that they experienced either short-term headache, mild dizziness, need to reorient, and/or need to readjust vision once out of the headset.

Debriefing was used in this protocol as it is a valuable tool needed for IVR simulations (Verkuyl et al., 2018). Participants using IVR provided valuable feedback from the debriefing process based on their narrative descriptions of the experience. Students were excited to have a new technology to supplement their nursing education. Students shared that it 'put them with the patient' and 'made me think for myself'. The students said, 'it felt real', 'like a dream' and 'a little like magic.' They verbalized, 'I learned, critically thought, problem solved, and had to prioritize.' Students expressed that throughout clinical experiences in a healthcare setting, there was always someone else to rely on. In the IVR experience, it made them feel responsible for the patient, 'that they couldn't rely on others but had to be the responsible one, the real nurse'. As simulation experiences do, IVR allowed the students to have a safe environment to learn and make mistakes. For this simulation, students were alone in the IVR environment, which required students to rely on their individual thinking processes versus a team simulation of four-six team student members, thus providing a different type of situation. Throughout the IVR simulation days, appropriate times were scheduled, and the faculty were able to conduct the prebriefing, IVRs, and debriefing within the 90-minute allotted time.

Discussion

Integrating IVR into a BSN curriculum is a viable and feasible option to provide engaging simulation to nursing students. Hardware, software, adequate space, internet capabilities, and faculty training were planned and evaluated. Orientation of faculty and students involved was offered and education on moderating IVR was provided to the involved nursing faculty. Implementation included planning time, scenario development and selection, creation of student schedules, as well as objectives and learning activities associated with the IVR assigned. All students completed the prework assigned and attended the briefing, IVR simulation, and debriefing. Running up to four stations simultaneously allowed 90 students to complete the scenarios in 2.5 days. Faculty to student ratio for the IVR simulation was 1 to 2, while pre-brief and debrief had a ratio of 1 to 8.

There were many lessons learned during implementation. Some faculty voiced concerns and hesitancy to use IVR. Many times fear of change or unfamiliarity with a process can cause anxiety in faculty. Faculty resistance to change needs to be addressed and faculty educated on the use, benefits and limitations of IVR. The earlier in the implementation process these conversations can occur, the more beneficial they will be. Internet bandwidth must be taken into consideration when running scenarios moderated via a laptop. We ran the scenarios on multiple different internets than just the one used by the students who were in the classroom to ensure we had enough bandwidth to avoid any lagging during the simulation. We used four headsets at a time and found they held their charge

approximately 4 hours and would recharge over a lunch period and would be ready for the afternoon. We would recommend having 2-3 extra headsets charged and ready to go in case the ones being used unexpectantly ran out of charge. Another consideration when evaluating space is to remember noise levels. We recommend spacing the simulation stations far enough apart so conversations that occur during the simulation do not distract students in the headset. We also found we had to remind students objects in the scenarios were not real and to not lean on, step on and set items on the images in the headset so the student would not lose their balance or damage the hand controllers. After reviewing cleaning protocols particularly in light of COVID-19, we determined the best way to clean the headsets between use was to wipe the headsets and hand controllers down with disinfectant wipes and use a CLEANBOX© (Nashville, TN) to provide UVC light exposure to clean the headset. Headsets only had to be placed in the CLEANBOX© for 60 seconds. Selection of scenarios was based on student level, course concepts and clinical needs.

An advantage of IVR is that it can provide students with clinical experiences that otherwise would be limited, such as interacting with a patient with COVID-19. Providing IVR experiences can better prepare student nurses for the complex patients they will be caring for as new graduate nurses. IVR can offer students seemingly limitless types of settings difficult to find, such as multiple patient prioritization scenarios, home health, primary care, life-threatening scenarios, and mental health. IVR also provided opportunities for the students to practice interprofessional communication. Participants took report, called physicians using SBAR, communicated with respiratory, radiology, and laboratory, and provided handoffs. Many opportunities were created in the simulation that these students may have only observed in the clinical setting. Sitterding et al. (2019) discuss even continuing IVR post-graduation to ensure new graduate nurses continue this learning, such as specifically recognizing and responding to patient deterioration.

IVR can be easy to implement and can be used successfully even when students may not have experience in IVR (Chang & Lai, 2021; Smith et al., 2018). Most students indicated a desire to continue the use of IVR as a learning modality. This finding supports the use of IVR in nursing education. This is consistent with previous literature supporting IVR is preferred over modalities such as reading, didactic, and even online teaching (Adhikari et al., 2021; Botha, de Wet, & Botma, 2021; Hardie et al., 2020; Zackoff et al., 2020).

Students were engaged in the IVR and engagement was strongly correlated with learning as the literature has indicated that engagement is key to capturing the students' interest and initiates learning. Immersion into the clinical experience allows students to have the experience of the clinical setting (Hardie et al., 2020; Shoery & Ng, 2021). In addition, Shoery & Ng (2021) conducted a systematic review that found immersive and engaging experiences to be the most effective in improving cognitive outcomes.

IVR may not be for every student. A select group of students may not tolerate the IVR activity (i.e., cybersickness), thus faculty must be prepared to offer alternative learning experiences to accommodate students' needs. Vision, such as colorblindness, can be a challenge recognized in the literature, as well as the length of time in the IVR (Botha et al., 2021). Botha et al. (2021) recommend the time in the headsets remain around 20 minutes. Our scenarios followed the recommended guidelines. Another constraint may be faculty hesitancy to learn new technology or concerns regarding cost. Farra et al. (2019) evaluated the cost of virtual reality vs live simulation with manikins and found that virtual reality was initially more expensive when considering planning, development, and implementation. However, when extrapolated over a three-year period, virtual reality was less expensive than the live simulation with manikins. Oculus headsets currently cost $399.00, in this study the investigators had four IVR simulations running at a time. Scenarios can be

purchased pre-made or written and designed by the faculty with the support of a development company. Cost varies depending on the application and license.

Implications for Future Research

Limitations of this study include convenience sampling, single site, one cohort of nursing students, and student self-reported data. This article discussed engagement and self-perceived learning, but studies are needed in relation to clinical judgment and competency outcomes associated with IVR simulation experiences. Further collaboration is needed with other sites to coordinate large multi-site studies. Larger studies are needed within nursing programs to determine IVR best practices that can be incorporated into practice standards such as the INACSL Healthcare Standards.

Further studies are needed more globally to answer the plethora of IVR questions to be evaluated. Exemplars for further study of IVR to be answered include: How can faculty best deliver IVR in relation to and in combination with manikin simulation? Is there a best practice to be studied in the implementation and activation of IVR with manikin simulation? Can IVR provide quality home simulation for students in an era of distance education? In addition, what are the effects of delivering this type of innovative education? Although students can be alone during an IVR simulation, we need to explore how we can include more than one student in the IVR environment, including other healthcare roles and/or avatars to simulate teamwork.

Additional research is needed to evaluate IVR use for interprofessional education, allowing multi-users in different professional roles to care for complex virtual patients. Research extending IVR as a transitional tool after graduation and included in nurse residency programs also needs to be explored. The collaboration of using a continuum of virtual worlds to interrelate academics and practice can improve the transition to work experience. IVR can offer interprofessional opportunities with nurses and other healthcare professionals. Studies of IVR could also be used as a mechanism to educate and train nurses and other healthcare workers across a wide range of "educational" opportunities (e.g., returning to the workforce, orientation to new/changes in work responsibilities).

Conclusion

Incorporating IVR into a BSN curriculum is feasible and provides an engaging, flexible, learning environment. IVR provides a positive learning experience and overall students want to continue to use it in the future. IVR does have a few limitations that need to be considered. IVR may create motion sickness for a small percentage, and alternative experiences must be available. If students do not have their own headsets, a plan must be in place for cleaning between use, especially in the era of COVID-19. Faculty must be oriented and comfortable with IVR even if staff are present to provide technical support. Running an IVR simulation can be a faculty-intensive workload experience. Further research needs to be done comparing IVR directly to manikin simulation and in combination with manikin simulation. Further research to establish IVR best practices needs to be completed. Finally, further research is needed to evaluate the usefulness of IVR for among other healthcare professionals.

Declaration of Conflicting Interests

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