Spring 5-6-2022

Perceptions of Integrating Immersive Virtual Reality Simulation as a Teaching Methodology in a Hospital Setting

LaDonna Christy
The University of Texas Health Science Center at Houston - Cizik School of Nursing

PERCEPTIONS OF INTEGRATING IMMERSIVE VIRTUAL REALITY SIMULATION AS A TEACHING METHODOLOGY IN A HOSPITAL SETTING

A DISSERTATION

SUBMITTED IN FULFILLMENT OF THE REQUIREMENTS

FOR THE DEGREE OF DOCTOR OF PHILOSOPHY IN NURSING

THE UNIVERSITY OF TEXAS HEALTH SCIENCE CENTER AT HOUSTON

CIZIK SCHOOL OF NURSING

BY

LADONNA CHRISTY MSN, RN, NEA-BC, CCRN-K, NPD-BC, CHSE

MAY, 2022

UTHealth Cizik
The University of Texas Health Science Center at Houston
School of Nursing

Approval Form D-3

Feb 14, 2022
Date

To the Dean for the School of Nursing:

I am submitting a dissertation written by LaDonna Christy and entitled " Perceptions of Integrating Immersive Virtual Reality Simulation as a Teaching Methodology in a Hospital Setting." I have examined the final copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Nursing.

Melanie McEwen, PhD, Committee Chair

We have read this dissertation
and recommend its acceptance:

PhD, RN

Accepted

Dean for the School of Nursing

Acknowledgments

I would like to thank my heavenly father who knows the desires of my heart. He is my strength and my salvation.

My family has always been my biggest supporters. I love each of you more than life itself and I couldn't have made it through this journey without all of your prayers, support, and guidance. I share this dissertation with you as I grow in my practice. To my mother, who never holds her tongue and always tells me to be fearless and tackle each obstacle through prayer and supplication, I love you and I am glad I share this life with you.

To Dr. Melanie McEwen, you have supported me even when I could not see my success in myself. I thank you for your compassion and direction. To Dr. Ottosen, this day would not be completed without your continual guidance and structure. The many late-night phone calls, texts and continuing messages makes this journey more meaningful. To Dr. Franklin- thank you for pulling the technology geek out of me, I enjoyed the journey.

Finally, to Dr. Shannan Hamlin- thank you for giving me support and mentoring using human kindness. You pushed me to be a better version of myself.

To LaSandra Brown- Thank you for the opportunity to impart my vision in leadership, and to being the most loyal friend anyone could ever have.

To my education colleagues, Kathryn Roberts, Shedrick Kennedy and Tracee Lamb- we have grown up in the simulation world as newbies, educators, and advanced simulation specialists. The collaboration and partnership between our programs will continue throughout my life's work in simulation design through virtual reality.

Finally, to my dearest Luis. As I taught you about simulation, you taught me how to perform it better. I am humbled to have known one of the world's future emerging physicians.

LaDonna Christy, PHD(c), RN, NEA-BC, CCRN-K, NPD-BC, CHSE

Perceptions of Integrating Immersive Virtual Reality Simulation as a Teaching Methodology in a Hospital Setting

May, 2022

Abstract

Introduction

As newly licensed nurses enter the workforce with limited experience and limited clinical reasoning skills, nursing educators must employ innovative strategies to teach graduate nurses how to identify and manage clinical deterioration – skills which are vital to saving lives and improving outcomes. Fully immersive Virtual Reality (VR), (also defined as Immersive VR) is one effective educational strategy available for hospital educators to use for preparing newly licensed nurses to recognize and manage clinical deterioration.

Objective

The purpose of this study was to explore perceptions of hospital-based nurse educators, simulation specialists, and nursing leaders with respect to integrating immersive VR to teach management of clinical deterioration to newly licensed nurses. The primary goal of this study was to assess the facilitators and barriers associated with integrating immersive VR.

Methods

A generic qualitative descriptive approach employing group and individual interviews was undertaken using purposive sampling of experienced hospital nursing educators, nurse simulation specialists and education department administrators. Data were analyzed using thematic analysis.

Results

Fifteen individual and one group interview were conducted using semi structured interviews. Participants indicated that use of immersive VR for educating newly licensed nurses could prove successful in their organizations if they had the proper resources, time to learn and develop the training modalities, create scenarios that were relevant to the learner's needs, and financial/logistical support from the organization's stakeholders.

Conclusion

Immersive VR may be an effective pedagogy for educating newly licensed nurses on managing clinical deterioration if sufficient resources are in place for its' support.

Table of Contents

Summary of Study

Virtual reality has been researched as a teaching methodology in medicine and nursing at the academic level, but limited studies have identified the use and effectiveness of virtual reality in hospital settings. The first step in determining if virtual reality can be used in the hospital setting is the assessment of how likely it will be adopted, and what resources would be needed to implement this educational strategy.

The research protocol for "Perceptions of Integrating Immersive Virtual Reality Simulation as a Teaching Methodology in a Hospital Setting" was approved by University of Texas' Health Science Center Committee for the Protection of Human Subjects (CPHS) on April12, 2021.The aims of this generic, qualitative descriptive study was to explore nurse educators', nurse simulation specialists', and nursing education department leaders' perceptions of integrating fully immersive VRS programs in the hospital setting for newly licensed nurses to teach management of clinical deterioration. Recruitment began on April 15, 2021 and was completed on August 20, 2021. Individual and group interviews were conducted via Zoom to ensure safe social distancing and to interview participants from different geographical areas.

Data saturation and redundancy was reached at 15 individual interviews and 1 group interview. The interviews were transcribed, coded, and analyzed with the qualitative expert on the dissertation committee. Participants included nursing leaders over education departments within hospital settings, nurse educators and simulation specialists who worked either in an unit-based or hospital-based education role. Participants interviewed were located within the United States and Canada.

Among the findings were that participants identified the need for more resources and support within hospital education structures to implement VR for newly licensed nurses. Findings also included the notation that success of using VR technology in the hospital would need a robust training program for educators implementing the programs as well as for the newly licensed nurses who would participate in the learning. Finally, financial and resources support from the leadership and stakeholders would be necessary. A manuscript was completed for publication to the *Society for Simulation in Healthcare*. This manuscript describes in detail: the background for the project, significance, research questions, approach, results, and implications for future research.

Perceptions of Integrating Immersive Virtual Reality Simulation as a Teaching Methodology in a Hospital Setting

Proposal

Abstract

Background

In the acute care hospital setting, identifying the signs of clinical deterioration in patients is crucial to saving lives and improving outcomes. Missed opportunities in detecting the early signs of clinical deterioration cause a delay in the escalation of care. As newly licensed nurses enter the workforce, have limited experience, and limited cognitive/clinical reasoning skills, nursing educators must have new and innovative educational strategies in place to train management of clinical deterioration. Fully immersive Virtual Reality Simulation (VRS) may be an effective educational strategy for hospital educators to use for training newly licensed nurses to manage clinical deterioration.

Objective

The purpose of this study is to explore the nurse educator, simulation specialist and nursing leader's perceptions of integrating a fully immersive VRS program in the hospital setting for newly licensed nurses for teaching management of clinical deterioration. The primary goal of this study is to assess the facilitators and barriers associated with integrating fully immersive VRS technology in the hospital setting.

Methods

Using the Educational VR System Framework, a generic qualitative descriptive approach will be used to explore hospital setting nurse educators' perceptions of

integrating fully immersive VRS as a learning platform to train newly licensed nurses in the management of clinical deterioration. Purposive sampling will be used to recruit nurses with at least two years' experience in the role of hospital nursing educator, or nurse simulation specialist via various sites through permission from the appropriate personnel to post and email recruitment flyers via email. A semi structured interview format will be used in group and individual interviews with a sample size up to 30.

Specific Aims

In the acute care hospital setting, identifying the signs of clinical deterioration in patients is crucial to saving lives and improving outcomes (AHRQ, 2019). Missed opportunities in detecting the early signs of clinical deterioration cause a delay in the escalation of care (Vincent et al., 2018). Isolated reports from tertiary medical centers report 65% of failure to rescue cases lead to ICU admissions with 19.8% of those patients dying (Sankey et al., 2016). As of 2019, the reported national average rate for failure to rescue was 13.9 % in post-surgical patients with treatable conditions; equating to unnecessary deaths, extended hospital stays and suboptimal outcomes (AHRQ, 2019). These rates are remarkable and require hospitals to initiate immediate strategies to improve patient outcomes.

Timely analysis of any change in a patient's condition starts with a nurse's identification of critical changes (Liaw et al., 2011). Cognitive/clinical reasoning, a skill that allows the nurse to critically evaluate a patient's subjective and objective data to interpret clinical status, is at the forefront of management of patient condition changes (Simmons et al., 2003). Clinical reasoning skills are undeveloped in the newly licensed nurse due to limited experiences. Over the last year, student nurse clinical rotations in

hospitals were prohibited due to the COVID pandemic leading to an increase in school-based virtual desktop simulation to satisfy clinical rotation requirements which led to lack of experiential learning (i.e., working with actual patients to develop cognitive reasoning and skills acquisition) (Fogg et al., 2020). As a result, hospital educators must fill the gap of training higher level concepts in a shorter amount of time; specifically, how to identify and manage a clinically deteriorating patient (Massey et al., 2016).

To address this gap, fully immersive Virtual Reality Simulation (VRS) may be an effective educational strategy for hospital educators to incorporate for training newly licensed nurses to manage clinical deterioration. Fully immersive VRS is a specific type of learner-focused simulation methodology that uses multi-sensory, 360-degree artificial environments to enhance the cognitive/clinical reasoning skills in many professions – including health care (Sanchez et al., 2000; Weiß et al., 2018). Fully immersive VRS can successfully promote learning in all learning domains at one time (cognitive, psychomotor, and affective), significantly reduce time to train multiple concepts and objectives, and lead to fewer student errors in the clinical environment (Alfalah, 2018; Foronda et al., 2013; McGrath et al., 2017). However, use of fully immersive VRS methodologies rely heavily on the readiness and motivation of nurse educators to actively support, participate, and integrate this teaching approach. Healthcare organizations need to understand the challenges, optimal VRS technologies and methods to facilitate prompt adoption (Alfalah et al., 2017; Alfalah, 2018; McGrath et al., 2017; Sitterding et al., 2019; Wang et al., 2016).

The purpose of this study is to explore perceptions of integrating fully immersive VRS programs in the hospital setting for newly licensed nurses to teach management of

clinical deterioration. It is vital to initially address if fully immersive VRS is a simulation methodology that is adaptable, acceptable, and time efficient for the nursing educators, and staff. This study seeks to answer: What are the perceptions of nurse educators working in the hospital setting regarding integration of a fully immersive VRS teaching methodology to train newly licensed nurses on the management of clinical deterioration? The primary goal of this study is to assess facilitators and barriers associated with integrating fully immersive VRS technology to train newly licensed nurses who work at the bedside in the hospital setting. The specific objective of this study is to explore perceptions of integrating fully immersive VRS and to identify strengths and weaknesses in the hospital setting regarding integrating this modality for training newly licensed nurses for management of clinical deterioration. The long-term goal is to implement a pilot program for newly licensed nurse training for management of the clinically deteriorating patient.

The overall objectives of this proposed study will be achieved through the following aims:

Aim 1: Explore nurse educator perceptions of integrating fully immersive VRS as a teaching methodology to train management of clinical deterioration to newly licensed nurses in the hospital setting.

Aim 2: Do the perceptions of integrating fully immersive VRS as a teaching methodology to train management of clinical deterioration to newly licensed nurses in the hospital setting differ by stakeholder group?

Significance

Clinical Deterioration

Clinical deterioration, which unnoticed can lead to failure to rescue, has many definitions in the current literature; deterioration is fundamentally expressed as the physiological movement from one clinical state to a worsened clinical state (Jones et al., 2013; Padilla & Mayo, 2018). As such, failure-to-rescue is defined as the failure to "prevent a clinically important deterioration" from an underlying illness or surgical complication (AHRQ, 2019; Ashcroft, 2004). Studies show that missed opportunities to detect early signs of clinical deterioration result in delaying care escalation (Vincent et al., 2018).

In turn, as of 2017, approximately 155,000 newly licensed nurses enter the workforce on an annual basis (Salsberg, 2018). The abundance of newly licensed nurses is prevalent in the hospital setting, as experienced nurses may be transitioning to travel opportunities amid the current pandemic, advanced degree roles and retirement. For this reason, newly licensed nurses may benefit from maturating clinical reasoning skills in a fully immersive VRS environment.

Clinical reasoning skills

Clinical reasoning skills in nursing are defined in the literature as a "recursive cognitive process that uses both inductive and deductive cognitive skills to simultaneously gather and evaluate assessment data" (Simmons et al., 2003, p. 701). As such, the first step in the nursing process, the assessment of the patient, is reflective of clinical reasoning skills (Benner, 1984; Simmons et al., 2003). Clinical reasoning skills allow the nurse to work through a cognitive process that incorporates the mental

processing of information to organize, evaluate and link patient needs with the use of inductive reasoning (Simmons et al., 2003). In consideration of the newly licensed nurse, these skills may be limited due to the limited experience of making patient care decisions at the bedside.

Regardless of limited experience, the nurse at the bedside assessing a patient has a duty and obligation to accurately document, report and escalate significant events regarding the patient's care (Texas BON, 2021). The National Council for State Boards of Nursing reported that the role of a nurse includes promoting safety and protection of the public while providing competent nursing care in all phases of nursing practice (NCBSN, 2021). As such, the obligation of the nursing educator and hospital organization rest on integrating and teaching high-level concepts quickly and efficiently to get the newly licensed nurse workforce out to the bedside with the needed skills. Clinical reasoning skills are necessary for nurses to be able to process and organize information to make decisions that will ensure patient safety and optimal patient outcomes. For this reason, VRS proves an effective pedagogy to maturate clinical reasoning skills, and simulation in healthcare has had a long evolving history that led to this technology (Padilha et al., 2019).

History of Simulation Methodologies

Healthcare simulation has evolved over the last 20 years to provide a learning platform that addresses variations in patients' conditions. Simulation is defined as "a technique that creates a situation or environment to allow persons to experience a representation of a real event for the purpose of practice, learning, evaluation, testing, or to gain understanding of systems or human actions" (Loprieto, 2013). The evolution of

simulation in healthcare began with the objective of skills acquisition for mastery of practice. Simulation can range from simple task trainer to VRS.

Task trainers, or low fidelity simulation, is a form of simulation that embodies specific manikins or body parts to teach healthcare professionals how to perform specific skills. For example, the first nursing simulation task trainer, entitled “Mrs. Chase,” developed in 1911, was a life size manikin with the objective of training nurses to bathe, transfer and turn patients (Aebersold, 2016). Additional iterations of Mrs. Chase included manikins with the objective of teaching care of the hospitalized patient (Aebersold, 2016).

In response to the growing need to train healthcare workers to respond to life threatening events due to cardiac or respiratory arrest, a resuscitation manikin, Resusci Anne was born. Resaca Anne, a redesigned manikin developed by Peter Safar and Asmund Laerdal, provided medical professionals a hands-on method to educate cardiopulmonary resuscitative strategies (Aebersold, 2016; Gordetsky et al., 2020). Addressing these patient interventions to improve untimely death led to an explosion of multiple technology platforms that allowed the learner to practice skills, critically think through concepts, and be immersed in different forms of robust, simulated learning. As such, high fidelity simulation, was the next step to integrating learning concepts in the academic and hospital setting.

High Fidelity Simulation (HFS)

High fidelity simulation (HFS) involves a computerized functioning manikin that delivers a level of realism, purposely similar to a clinical environment, which gives the learner the ability to cognitively assess and provide interventions and feedback based on

experience (Loprieto, 2013). A high-fidelity manikin can mimic human body functions, such as pulses, chest rise and fall for respirations and instructor activated voice responses (Loprieto, 2013). Multiple scientific papers have documented the positive impact of using high fidelity simulation as a teaching and learning methodology in nursing schools and hospital settings (Cant & Cooper, 2009; Christensen et al., 2016; Hegland et al., 2017; McGaghie et al., 2020; Prion & Haerling, 2020; Wayne et al., 2008). It is important to note HFS is resource intensive; to create a single scenario requires pre-setup, multiple educator/instructors to run the scenarios, and dedicated space to house the equipment and provide training (Cant et al., 2019).

Virtual Reality Simulation (VRS)

With the creation of the first version of the virtual reality headset titled "The Sword of Damocles," fully immersive virtual reality was born; this has allowed educators a new pedagogical platform (Cant et al., 2019; Norman, 2005). Studies can be confusing regarding VRS nomenclature (Cant et al., 2019). The VRS environment has two overarching categories of delivery: non-immersive and fully immersive (Alfalah, 2018). Non immersive VRS involves screen-based learning using a desktop computer or computer interactivity. This sort of simulation depicts scenarios/skills on a computer screen (Cant et al., 2019). There are multiple studies that report the efficacy of non-immersive VRS in the academic and hospital setting using a computer desktop interactivity to integrate learning concepts.

Fully immersive VRS environments allow the instructor to run a preprogrammed scenario, with flexibility to setup the environment anywhere. In contrast to non-immersive VRS, fully immersive VRS provides an enclosed real life replicated scenario

through the use of head mounted display and handheld manipulated devices. This form of VRS incorporates behavior, senses, emotions and cognition to work through a problem or concept (Cant et al., 2019; McGrath et al., 2017). Fully immersive VRS environments combine all aspects of learning domains, allow the learner to work cognitively through a problem, and utilize less resources to perform.

There is an abundance of literature using VRS in nursing education; however, studies focus heavily on the efficacy of non-immersive screen-based training software (Weiß et al., 2018). In fact, as of 2018, evaluation of the efficacy when using fully immersive VRS with head-mounted displays are "missing "or limited in nursing education (Madden et al., 2020; Weiß et al., 2018), and a growing need exists to evaluate the effectiveness of fully immersive VRS in nursing education to examine cognitive phenomenon (Samadbeik et al., 2018). As such, this study will evaluate perceptions of integrating fully immersive VRS, eliciting responses that identify facilitators and barriers to integration in the hospital setting.

Theoretical Framework

The theoretical framework for this study is the Educational VR System Model (Alfalah et al., 2017). The model proposes the elements needed for successful integration of VRS methodologies are guided by the perceptions of students and instructors (Alfalah et al., 2017; Alfalah, 2018). The authors specifically report the model will serve "a useful reference framework for embedding VR (virtual reality) in any pedagogical program as an educational technology" (Alfalah et al., 2017, p. 464). Because virtual reality itself is an emerging concept with an evolving number of attributes, the integration of VRS

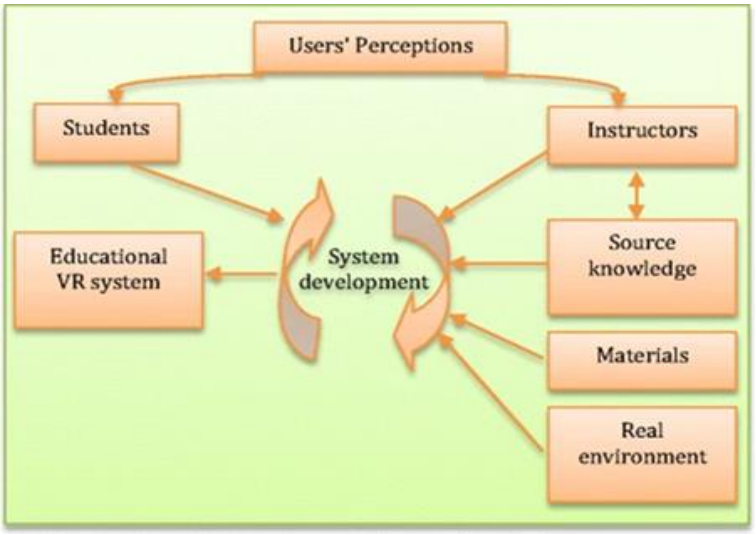
education relies heavily on the instructors' perception as they will adopt and use the system (Alfalah, 2018). The model asserts the following principles:

- User perceptions - The perceptions of the system users toward adopting VR technology as a learning medium
- Source knowledge - Represents all the concepts and skills to be learned by the student.
    - Real Environment - The setting in which teaching takes place.
    - Materials - Represents didactic materials and information related to the subject.
- System Development/Educational VR System - The actual implementation of the VR system (Alfalah, 2018, p. 2640)

Thus, based on the model, the first step to adopting the VRS program in the hospital setting begins with identifying perceptions. Users' perceptions of the model's principles can identify how likely the success of the organization will be when integrating fully immersive VRS into teaching programs for nurses. The nursing educator's (i.e., instructor's) assessment of integrating this form of technology as an educational platform is critical to successful implementation (see Figure 1).

Figure 1

Education VR system model



Benner's Novice to Expert Model

Benner's Novice to Expert model places the nurse's skill and cognitive modeling in categories that addresses the levels of expertise that range from novice to expert (Benner, 1984). Asserting that expertise of the nurse increases with time and experience, the theory attempts to categorize the knowledge, proficiency, and gaps in practice (Benner, 1984). Each category advances from the previous level and includes novice, advanced beginner, competent, proficient, and expert (Benner, 1984). As the newly licensed nurse has had some exposure to the hospital setting, they will enter the workforce as an advanced beginner which allows them to identify patient condition changes (Benner, 1984). At this stage they lack the cognitive/clinical reasoning to appropriately respond. Nursing educators have a responsibility to train, advance and assess the newly licensed learner's cognitive/clinical reasoning. For this reason,

integrating immersive VRS strategies may prove an effective, time-saving training methodology for newly licensed nurses in the management of higher-level concepts such as clinical deterioration (Shorey & Ng, 2021; Sitterding et al., 2019).

Innovation

Due to the literature gap in integrating immersive VRS in registered nurse training, this study is a novel concept in that it will address the first component to integration by exploring user facilitators and barriers (Alfalah, 2018). Once integrated, using fully immersive VRS shifts the training paradigm of hospital educators, as traditional educational methodologies involve some form of lecture, case-based discussion, and if available, low and high-fidelity simulation (Xu, 2016). In fact, as the COVID pandemic has changed the way people live, work, and interact, fully immersive VRS may eventually move to be the first educational platform of choice to maintain social distancing and learner safety. Not only is the literature scarce regarding fully immersive VRS as a strategy to teach nurses in the hospital setting, it is essentially "missing" (Shorey & Ng, 2021; Sitterding et al., 2019; Weiß et al., 2018; Zackof et al., 2020). VRS is anticipated to become a standard, more relative training methodology as educators face time restrictions in an effort to get newly licensed nurses out into the workforce quicker (McGrath et al., 2017). Findings from this study will be a valuable enhancement to understanding nurse educator perceptions of using VRS as a new methodology to facilitate successful transition to practice in the newly licensed nurse (Zackof et al., 2020).

Approach

Research Design, Sample and Setting

Design

A generic qualitative descriptive approach will be used to explore hospital-based nursing educators, nursing education leaders and nursing simulation specialists' perceptions of integrating fully immersive VRS as a learning platform to train newly licensed nurses how to manage clinical deterioration.

Setting and Sample

Zoom web-based video conferencing (Zoom, 2021) will be used as the platform to conduct the interviews of the sample who work in various hospital settings across the United States. The advantage of using the virtual interview platforms include the ability to recruit participants in hospital settings in different geographical locations to add an array of "rich" perspectives from like individuals (Maher et al., 2018, p. 3).

Purposive sampling will be used to recruit hospital-based nurse educators representing a mixture of roles such as nursing educator, simulation specialist, and nursing leader over an education department. As this study seeks to explore barriers and facilitators of integrating fully immersive VRS in a hospital setting, participants will be recruited until saturation of the data is achieved to answer the aims of the study.

Inclusion Criteria Nurse educators, nurse simulation specialists, and/or nursing leaders over education departments with 2 years' experience in a hospital setting will be included in the study if they meet at least one of the following: 1) have experience using some form of simulation (i.e., task trainers/low fidelity simulation, HFS, or non-

immersive/fully immersive VRS), 2) work currently in one of the following hospital settings: teaching hospital, nonprofit or for-profit organization, large hospital (500+ bed) or community/rural hospital setting, and 3) agree to audio-video recording of the interviews.

Exclusion Criteria Those who do not meet the inclusion criteria. Educators, simulation specialists and nursing leaders who do not work in a hospital setting or have less than 2 years' experience as an educator in a hospital setting will be excluded. No subjects will be excluded based on their knowledge of VRS, age, gender, race, or ethnic group.

Based on previous studies, it is anticipated that up to 30 participants will be needed, as previous studies support a minimum of 20-30 studies to achieve saturation (Guest, et. al., 2006). Enrollment of participants will continue until data saturation is achieved (i.e., the participants are providing similar responses to interview questions) (Green & Thorogood, 2018).

Recruitment Strategies

Prior to recruitment, approval for this project will be obtained from the UTHSC's Committee for the Protection of Human Subjects (CPHS) institutional review board. Recruitment strategies will include seeking permission from nursing professional organizations geared toward nursing education and nurse simulation healthcare specialists, such as The Association for Nursing Professional Development (ANPD) local Houston chapter, and the Society for Simulation in Health Care (SSIH) national organization, to access member banks and post recruitment flyers (see Appendix E) on their websites. The PI will also recruit within her professional network to obtain participants via email. In addition, nurses that currently work in a hospital setting as a

nursing educator, leader over a nursing education department, or simulation specialist who attend The University of Texas Health Science Center (UTHSC) at Houston's Cizik School of Nursing as a student in an advanced degree program will also be recruited through permission from the appropriate personnel to post recruitment flyers on advertisement boards and send recruitment flyers via email (see Appendix E).

After the potential participant reaches out to the PI, the PI will provide information about the study. The PI will follow the phone screening CPHS verbal consent form for inclusion screening (see Appendix B) and answer any questions the participant may have. Once the PI confirms the potential participant meets criteria and agrees to be a part of the study, the PI will complete the CPHS verbal consent form through phone conversation (see Appendix B). The participants will complete one verbal consent for one or both interviews (see Appendix B).

Data Collection Procedures

Data collected for this study include sociodemographic variables, a semi-structured interview guide for group and individual interviews conducted via Zoom, and observation field notes of the interviews.

Sociodemographic Variables

The purpose of the sociodemographic assessment is to identify key features of the participants that may be linked to the responses of the interview questions (Crabtree & Miller, 1999). Sociodemographic variables that will be assessed include age range, description of job role, education, employment status, ethnicity, years of experience as a nurse, years of experience in the current role as an educator or simulation specialist, experience with simulation and hospital setting (see appendix A). Sociodemographic

variables will be collected before the start of the interview. After the participant agrees to be a part of the study, the PI will send an encrypted fillable pdf through email for the participant to fill out. The PI will inform the participant that the form and link is encrypted and confidential and need to be completed before the start of the interview. The PI will receive email notification from the web-based platform when the form is completed. If any of the participants have not completed the sociodemographic questionnaire before the start of the interview, the PI will remind them to complete at the start of the interview.

Pilot testing of data collection

Pilot tests of group and individual interviews were conducted with nurse educators familiar with the project to evaluate the wording and flow of the interview guides and troubleshoot the use of Zoom technology for this purpose. 4 pilot interviews were conducted: 2 group interviews with 5 participants each and 2 individual interviews. The 2 group interviews were comprised of nursing educators with simulation experience, and the 2 individual interviews incorporated 1 hospital nursing educator who trains newly licensed nurses and one nursing leader over an education department. After the interviews the PI asked for feedback in the individual and group interviews concerning the interview process. While the 2 groups provided feedback related to the interview flow using the interview guide, the individual participants provided feedback regarding which questions needed to be refined, and suggestions of what they would have asked as a stakeholder. It was also found that while the group interviews provided sufficient responses, the individual interviewees provided robust responses and were willing to share an unlimited amount of information. Feedback responses developed initial themes

that included: fear of technology, allocation of resources, financial constraints and availability and bandwidth of internet.

As such, results of the pilot interviews were concurrent with findings in the literature: initially conducting group interviews can provide “breadth”, i.e., a broad variety of views and experiences to set the groundwork for individual interviews which provide more “depth” (Morgan, 1997; Crabtree & Miller, 1999, p. 18).

Interview guide, Group interviews, Individual interviews, and Zoom platform

As a result of the pilot interviews, a group interview will be conducted initially to provide breadth of perspectives, a range of responses, and insight for conducting the individual interviews (Morgan, 1997; Crabtree & Miller, 1999). After completion of the group interview, the PI will then conduct individual interviews to complement the data obtained in the group setting and increase depth to the study (Morgan, 1997). Based on unique responses during the group interview, a participant may be invited to complete an individual interview. Participants who meet the inclusion criteria and agree to be in the study will have a choice to participate in either the group or individual interview. All group and individual interviews will be conducted using a semi structured interview guide during a 1-hour session, at a time convenient for the participant(s) (see Appendix C and D). It is projected that the interviews will take place over a 3–4-week period. Incentives for participation include a $10.00 Amazon gift card for the group interview, and a $10.00 Amazon gift card for the individual interview emailed to the participant at the completion of the interview. All interviews will be conducted via Zoom.

Zoom Web Based Interviews

Due to the COVID Pandemic, there are restrictions to holding group meetings. In addition, participants may be located in a large geographical area. To address these barriers, all group and individual interviews will be conducted virtually using Zoom, with 3-4 participants per 1-hour session. Zoom will be used to record video/audio and generate audio transcriptions at the completion of the interview. All scheduled interviews will be secured with a user passcode needed to enter the interview. Each participant will receive an email calendar invite with the link and passcode to the interview, a unique screen name with a 2-digit code, and instructions on how to change their screen name in the Zoom environment, to increase confidentiality. At the start of the interview, the participants will be placed in a waiting room until they can be identified by the PI through the use of the screen name and 2-digit code provided in the calendar invite. The 2-digit code will be linked to the sociodemographic form. Once the participant enters the interview, the participant will receive an audio notification when the recording starts (i.e., "this meeting is being recorded, by continuing to be in the meeting, you are consenting to be recorded") (Zoom, 2021). The participants will be reminded of this recording verbally and the PI will receive additional verbal consent before the start of the interview.

At the completion of interviews, all audio, video and audio transcriptions will be immediately downloaded to an encrypted location on the UTHSC network server that is secure to ensure confidentiality of the data. The PI will set the Zoom profile to reflect the UTHSC server address location for all recordings and transcriptions to be stored. A research assistant, who has completed the qualitative methods and qualitative analysis

courses at the UTHSC School of Nursing will assist with moderating the interviews, connection issues and participant observations.

Group Interviews

Group interviews provide a collective view of ideas communicated by a group, and allow the PI to explore user's views, stimulate opinions, ideas, and shared perspectives (Crabtree & Miller, 1999). The PI will use a semi-structured interview guide (see Appendix C) to facilitate the interview. As 6- 8 participants are traditionally scheduled during an in-person group interview, a maximum of 3-4 is preferred in the virtual setting so the participants and moderator can be easily seen on the screen as this enhances interactivity within the group (Dos Santos Marques et al., 2020; University of Nebraska at Omaha, 2020).

Individual Interviews

The purpose of the individual interview is to provide greater breadth and depth of unique thoughts and perceptions not expressed during the group interviews (Crabtree & Miller, 1999; Morgan, 1997). As the group interviews will be held first, participants from the group interviews may be selected for the individual interviews based on unique responses. Participants will be given a choice to participate in the individual or group interview. The interview will follow a semi structured interview guide (see Appendix D).

Interview Guide

Semi structured interview guides will be used to aid the PI in eliciting responses from the participants. The PI will use two separate interview guides: one for the individual interview and one for the group interviews. The interview guides will include an introduction, reminding the participants to complete the sociodemographic survey,

instructions for the group in the zoom environment, introduction of the purpose of the research, and restatement of confidentiality and monetary compensation (see Appendix C and D). Final interview questions will be reviewed and approved by experts of qualitative design on the dissertation committee prior to the study initiation (see Appendix C and D).

First, the researcher will build rapport with light conversation and set the tone by introducing herself, and her expertise on the subject. The PI will then inform the group that all ideas are to be shared and welcome for the benefit of generating empirical knowledge to improve learning in the newly licensed nurse's practice. The interview will start with a list of introduction questions and transition to review of a 5-minute video to set the tone of the conversation.

Next, using a conversational style format, the interview guide will include questions that address the following theoretical framework principles from the Educational VR System Model: user perceptions, source knowledge, real environments, materials, system developments, and educational VR system (Alfalah, 2018). Questions will also incorporate cognitive/clinical reasoning. Question topics will initially be generalized, and become more specific as the group shares perceptions, ideas and thoughts. Probing questions will be explored to seek additional information not discussed by the participants; the PI will look for inconsistencies in the participant's verbal and nonverbal communication and use probing to explore further, as specific details based on personal knowledge "improve the credibility and general quality of the data" (Carey & Asbury, 2012, p. 64). The guide may be iterative to incorporate additional questions as topics emerge from individual and group interviews. The interview will be concluded

once the participants have been allowed to discuss any additional thoughts they may have.

Field notes

Field notes provide opportunities to record the interviewer's observations of the participants during interviews (Spradley, 2016). The interviews will be completed via Zoom with video, so the PI is able to observe the participants during the group and individual interviews. Field notes provide further opportunities for the PI to jot down thoughts during interviews that may be lost or forgotten). Field notes will be transcribed by the PI during the interview to capture her own thoughts/perceptions identified at the corresponding place during key time points of the interview transcriptions and will be included in the data analysis. The use of bracketing will be used to reflexively assess the PI's own perceptions of the observations and responses. Bracketing will also allow the PI to examine her own influence (i.e., background, personal qualities and beliefs that may influence the analysis) (Fischer, 2009; Saldana, 2016).

Data Analysis

Thematic content analysis is a flexible approach to search for meaning and patterns across the data, in this case, interviews and observations (Braun & Clarke, 2006). Due to limited knowledge in the literature on the purpose of the study, the PI will take an inductive approach to the analysis; inductive approach is used when there is a limited amount of knowledge or science of the phenomenon (Elo & Kyngäs, 2008; Braun & Clarke, 2006). Throughout the steps of the analysis of the data, the PI will employ a latent approach, through making sense of the data and looking for underlying

assumptions and ideologies that may add importance to coding the data and emerging the themes (Braun & Clarke, 2006; Saldana, 2016).

After each interview is completed, the PI will review the transcribed Zoom recordings, and make notations of thoughts, and observations (the PI will identify time stamps provided by Zoom meeting technology- to identify where to place each field note). Data analysis will be conducted concurrently with, and after data collection. During the interviews, the PI will listen and observe each participant and generate observation field notes for further notations in the data. ATLAS.ti, a computer-assisted qualitative data analysis software will be used to organize and manage the data.

The PI will evaluate the data using the following strategy: listening to the audio recordings and immersing in the transcriptions by reading the transcriptions multiple times to become familiarized with the participants' perspectives, reviewing data line by line of every comment provided by each participant. In addition, the PI will review the transcriptions against the observations of the participants in the interviews to signal if the responses reflect the participant's body language, inflection of voice, and facial expressions. Reviewing the transcriptions against participant behaviors, or "looking and listening" can also assist the researcher to better identify subtle cues that may lead the researcher to elucidate responses for future interviews, taking into account the setting and knowledge base/experience of the participants (Crabtree & Miller, 1999 p.14; Spradley, 2016).

A codebook, that will provide definitions and uses for codes, will be developed for organizing and coding the data and used throughout the analysis (Green & Thorogood, 2018). Open coding will be used to highlight and notate sentences and

phrases that emerge from the transcripts (Braun & Clarke, 2006). Initial codes will be developed based on organizing the data relevant to the code. The PI will then organize the codes into several categories of themes. Several codes may be incorporated into one theme; initial codes may form primary themes and secondary themes at this stage codes may be removed if the PI determines they are not relevant to the phenomena and do not purport to answer the research questions and aims. Themes will be reviewed against the transcriptions to ensure they characterize an accurate representation of the data. At this stage, themes may be renamed be refined and named in correlation to the research questions and aims.

Rigor and validity will be assured through assessment of trustworthiness of the data. Four elements need to be satisfied to address trustworthiness (credibility, confirmability, transferability, and dependability) (Maher et al., 2018, p. 2). Credibility will be addressed through careful review of all transcriptions and video recordings to identify the responses that convey the phenomena; the PI will review the data for themes linked to the research aims, theoretical framework and how well those themes are exemplified through the data (Noble & Smith, 2015; Whittemore et al., 2001). As such, the PI will take a reflexive approach when analyzing the data, being aware of her own self reflections and preconceptions that may affect the evaluation of the data (Korstjens & Moser, 2017; Braun & Clark, 2006).

To further validate credibility, confirmability will be addressed through the use of explicit documentation of reflections, personal influence, (Korstjens & Moser, 2017). The PI will document the research steps taken from the start of the project to the "development and reporting of the findings" that includes all data collection, analysis and

interpretation (Korstjens & Moser, 2017, p. 121). The PI will confer with the qualitative expert on the dissertation committee when analyzing the transcriptions, and if needed, the PI may hold a peer debriefing session with qualitative experts at the UTHSC School of nursing to review the data.

Transferability will be evaluated in consideration that it can be applicable to other settings; author report that transferability incorporates "thick description, or the use of paying attention to contextual detail" to assess for transferability in other settings (Maher et al., 2018, p. 3). A detailed descriptive process of the analysis will be utilized to ensure dependability and repeatability of the research. All notes, reflective observations, and outline of the analysis phases will be preserved.

Descriptive statistics such as frequency, mean, and standard deviation will be used to describe the sociodemographic data of participants. Data will be analyzed using SPSS version 25.0 (Armonk, NY: IBM).

Data Management

All software, login passwords and Zoom access will be restricted to the PI and the dissertation committee members. A laptop encrypted by the UTHSC's information technology department will be used to hold the virtual interviews. The encrypted laptop will be secured in a locked cabinet in the office of the PI; only the PI will have access to the locked cabinet.

Sociodemographic questionnaires will be completed using a web based encrypted survey platform. At the completion of interviews, all audio, video transcriptions, field notes and sociodemographic data will be immediately downloaded to an encrypted location on the UTHSC network sever that is secure to ensure confidentiality of the data;

only the PI and dissertation committee members will have access to the data stored in the UTHSC server. The Zoom environment will be restricted to the interview participants via a link to their email address with a passcode to enter the interview. A name and 2 digit code given to the participants for the interview sessions will be linked to the sociodemographic form. It is anticipated the full data collection process and analysis will take approximately 4 months. All data will be stored within the University of Texas Health Science Center's (UTHSC) encrypted secure network server in accordance with UTHSC policy.

Potential Pitfalls, Limitations and Alternative Strategies

Because of the qualitative nature of the design, the PI will follow stated interviewing techniques and transcription/analysis of the data. Scheduling of group and individual interviews may prove a challenge as the participants in the sample may have different working schedules. All efforts will be made to accommodate interview times. There may also be connectivity issues with Zoom technology- it is known that bandwidth of the PI and participants can cause slower connectivity. To address this, the PI will perform a trial run and address connectivity speed and bandwidth; Zoom purports that the host of the Zoom software can appropriately identify connection strength (Zoom, 2021). The PI will include a research assistant who is also a PhD student at the UTHSC's Cizik School of Nursing, to assist with the interviews.

Participants may not be willing to share concepts and further ideas or thoughts within the group or individual interview; the PI will inform the participants they do not have to answer any questions they do not feel comfortable with, and they are able to withdraw from the study at any time. This study will set the groundwork for future

studies in VRS technology that will identify factors that lead to positive outcomes to nursing practice.

Human Subjects and Data Sharing

The CPHS verbal consent script (see appendix B) will clearly state the purpose of the study, overview of the selection/interview process, benefits, risks, confidentiality, and contact information of the PI. The PI (who will be conducting all of the interviews) will then follow a set of approved questions developed by the PI and experts in qualitative research on the dissertation committee. The questions, qualitative in nature, will guide the participants in responding with perceptions based upon their own knowledge base of information.

Unidentifiable sociodemographic information will be collected (Appendix A). In addition, a unique name and 2-digit code will be assigned to each participant and used on all data collected to protect the privacy of the participants (Polit & Beck, 2017). Additionally, the researcher will use codified terms to refer to participants, which will enhance the confidentiality of participants and data (Polit & Beck, 2017). At the completion of interviews, all audio, video and audio transcriptions and sociodemographic data will be immediately downloaded to an encrypted location on the UTHSC network sever that is secure to ensure confidentiality of the data. All data downloaded in the UTHSC network server will be restricted to access of the PI and dissertation chair, Final documents will be maintained on a secured server at the UTHSC School of Nursing under password-protection. Data records will be retained by the guidelines set forth by the University of Texas Health Science Center at Houston Cizik School of Nursing's University's policy.

Participants in this study may benefit in that nursing practice can be improved based upon the results. Increased knowledge and the eventual development of improved nursing educational strategies are examples of potential benefits. While there may not be direct personal benefits to participating in the study, participants will be encouraged to examine the influence of their personal actions upon nursing practice. The PI hopes that the information gained from this study will contribute to the scientific knowledge base regarding the development of nursing education to improve safe, effective care.

While no risks are anticipated, participants of this study may experience anxiety because they are invited to sort through their own ideas about perceptions of educational strategies. Although the interviews are anticipated to last 60 minutes or less, participants may become tired during the interview. Considerations (e.g., participants taking breaks or re-scheduling the interview if they wish to continue at a later date) will be offered by the interviewer to address these concerns. The participants will be offered reassurance regarding confidentiality of their responses and given the option to decline to answer any questions they might be uncomfortable with. Participants may end participation at any time during the study. Risks and benefits are clearly outlined in the CPHS verbal consent form recruitment script (see Appendix B).

References

Aebersold, M. (2016). The history of simulation and its impact on the future. *AACN Advanced Critical Care*, 27(1), 56–61. https://doi.org/10.4037/aacnacc2016436

Aebersold, M., Rasmussen, J., & Mulrenin, T. (2020). Virtual Everest: Immersive virtual reality can improve the simulation experience. *Clinical Simulation in Nursing*, 38, 1–4. https://doi.org/10.1016/j.ecns.2019.09.004

AHRQ. (2019). Failure to Rescue. Retrieved March 12, 2021, from https://psnet.ahrq.gov/primer/failure-rescue

Alfalah, S., Falah, J., Alfalah, T., Elfalah, M., & Falah, O. (2017). Perceptions toward Adopting Virtual Reality as a Learning Aid in Information Technology. *International Journal of Computer and Information Engineering*, 11(4), 463–467.

Alfalah, S. M. (2018). Perceptions toward adopting virtual reality as a teaching aid in information technology. *Education and Information Technologies*, 23(6), 2633–2653. https://doi.org/10.1007/s10639-018-9734-2

Ando, H., Cousins, R., & Young, C. (2014). Achieving saturation in thematic analysis: Development and refinement of a codebook. *Comprehensive Psychology*, *3*, 03.CP.3.4. https://doi.org/10.2466/03.cp.3.4

Archibald, M. M., Ambagtsheer, R. C., Casey, M. G., & Lawless, M. (2019). Using Zoom videoconferencing for qualitative data collection: *Perceptions and experiences of researchers and participants. International Journal of Qualitative Methods,* 18, 1–8. https://doi.org/10.1177/1609406919874596

Ashcroft, A. (2004). Differentiating Between Pre-Arrest and Failure-to-Rescue. *Medsurg Nursing*, 13(4), 211–216.

Benner, P. (1984). From novice to expert excellence and power in clinical nursing practice. *American Journal of Nursing*, 84(12), 1479. https://doi.org/10.1097/00000446-198412000-00025

Bradley, P. (2006). The history of simulation in medical education and possible future directions. Medical Education, 40(3), 254–262. https://doi.org/10.1111/j.1365-2929.2006.02394.x

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. Qualitative Research in Psychology, 3(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Brown, T., & Sorrell, J. (2017). Challenges of novice nurse educator's transition from practice to classroom. *Teaching and Learning in Nursing*, 12(3), 207–211. https://doi.org/10.1016/j.teln.2017.03.002

Butt, A. L., Kardong-Edgren, S., & Ellertson, A. (2018). Using game-based virtual reality with haptics for skill acquisition. *Clinical Simulation in Nursing*, 16, 25–32. https://doi.org/10.1016/j.ecns.2017.09.010

Cant, R., Cooper, S., Sussex, R., & Bogossian, F. (2019). What's in a name? Clarifying the nomenclature of virtual simulation. *Clinical Simulation in Nursing*, 27, 26–30. https://doi.org/10.1016/j.ecns.2018.11.003

Cant, R. P., & Cooper, S. J. (2009). Simulation-based learning in nurse education: Systematic review. *Journal of Advanced Nursing*, 66(1), 3–15. https://doi.org/10.1111/j.1365-2648.2009.05240.x

Carey, M. A., & Asbury, J.-E. (2012). Focus group research (1st Ed.). New York: Left Coast Press Inc.Chen, F.-Q., Leng, Y.-F., Ge, J.-F., Wang, D.-W., Li, C., Chen,

B., & Sun, Z.-L. (2020). Effectiveness of virtual reality in nursing education: Meta-analysis. *Journal of Medical Internet Research*, 22(9), 1–12. https://doi.org/10.2196/18290

Chen, F.-Q., Leng, Y.-F., Ge, J.-F., Wang, D.-W., Li, C., Chen, B., & Sun, Z.-L. (2020). Effectiveness of virtual reality in nursing education: Meta-analysis. *Journal of Medical Internet Research*, 22(9), 1–12. https://doi.org/10.2196/18290

Christensen, B., Mora, A., Benjamin, B., Blough, B., Duewall, J., & Columbus, C. (2016). Baylor University Medical Center, Dallas, TX Resident Training in Code Blue Execution in a Simulation Lab Improves Immediate Post-Code Survival. *Ochsner Journal*, 16, 15–16.

Corbin, J., & Strauss, A. (2015). Basics of qualitative research (4th Ed.). Sage Publications.

Crabtree, B., & Miller, W. (1999). Doing qualitative research (2nd Ed.). SAGE Publications, Inc. (US).

Cutcliffe, J. R., & McKenna, H. P. (2004). Expert qualitative researchers and the use of audit trails. *Journal of Advanced Nursing*, *45*(2), 126–133. https://doi.org/10.1046/j.1365-2648.2003.02874.x

Dos Santos Marques, I. C., Theiss, L. M., Johnson, C. Y., McLin, E., Ruf, B. A., Vickers, S. M., Fouad, M. N., Scarinci, I. C., & Chu, D. I. (2020). Implementation of virtual focus groups for qualitative data collection in a global pandemic. *The American Journal of Surgery*. https://doi.org/10.1016/j.amjsurg.2020.10.009

Fischer, C. T. (2009). Bracketing in qualitative research: Conceptual and practical matters. *Psychotherapy Research*, 19(4-5), 583–590. https://doi.org/10.1080/10503300902798375

Fogg, N., Wilson, C., Trinka, M., Campbell, R., Thomson, A., Merritt, L., Tietze, M., & Prior, M. (2020). Transitioning from direct care to virtual clinical experiences during the covid-19 pandemic. *Journal of Professional Nursing*, 36(6), 685–691. https://doi.org/10.1016/j.profnurs.2020.09.012

Foronda, C., Godsall, L., & Trybulski, J. (2013). Virtual clinical simulation: The state of the science. *Clinical Simulation in Nursing*, 9(8), e279–e286. https://doi.org/10.1016/j.ecns.2012.05.005

Gordetsky, J. B., Rais-Bahrami, S., & Rabinowitz, R. (2020). Annie, Annie! are you okay?: Faces behind the resusci anne cardiopulmonary resuscitation simulator. *Anesthesia & Analgesia*, 131(2), 657–659. https://doi.org/10.1213/ane.0000000000004889

Green, J., & Thorogood, N. (2018). *Qualitative methods for health research* (introducing qualitative methods series) (4th ed.). SAGE Publications Ltd.

Guest, G., Bunce, A., & Johnson, L. (2006). How many interviews are enough? *Field Methods*, *18*(1), 59–82. https://doi.org/10.1177/1525822x05279903

Gupta, N., & Raja, K. (2017). Expectations of persons with paraplegia regarding their care in India: A qualitative study. *Spinal Cord Series and Cases*, 3(1), 1–5. https://doi.org/10.1038/scsandc.2017.42

Hegland, P. A., Aarlie, H., Strømme, H., & Jamtvedt, G. (2017). Simulation-based training for nurses: Systematic review and meta-analysis. *Nurse Education Today*, 54, 6–20. https://doi.org/10.1016/j.nedt.2017.04.004

Jones, D., Mitchell, I., Hillman, K., & Story, D. (2013). Defining clinical deterioration. *Resuscitation*, 84(8), 1029–1034. https://doi.org/10.1016/j.resuscitation.2013.01.013

Korstjens, I., & Moser, A. (2017). Series: Practical guidance to qualitative research. Part 4: Trustworthiness and publishing. *European Journal of General Practice*, *24*(1), 120–124. https://doi.org/10.1080/13814788.2017.1375092

Liaw, S., Scherpbier, A., Klainin-Yobas, P., & Rethans, J.-J. (2011). Rescuing a patient in deteriorating situations (rapids): An evaluation tool for assessing simulation performance on clinical deterioration. *Resuscitation*, 82(11), 1434–1439. https://doi.org/10.1016/j.resuscitation.2011.06.008

Loprieto, J. O. (2013). Healthcare Simulation Dictionary. Agency for Healthcare and Research Quality. Retrieved February 5, 2021, from https://www.ahrq.gov/sites/default/files/publications/files/sim-dictionary.pdf

Madden, J., Pandita, S., Schuldt, J. P., Kim, B., S. Won, A., & Holmes, N. G. (2020). Ready student one: Exploring the predictors of student learning in virtual reality. *PLOS ONE*, 15(3), 1–26. https://doi.org/10.1371/journal.pone.0229788

Maher, C., Hadfield, M., Hutchings, M., & de Eyto, A. (2018). Ensuring rigor in qualitative data analysis. *International Journal of Qualitative Methods*, 17(1), 160940691878636. https://doi.org/10.1177/1609406918786362Massey, D., Chaboyer, W., & Anderson, V. (2016). What factors influence ward nurses'

recognition of and response to patient deterioration? an integrative review of the literature. *Nursing Open*, 4(1), 6–23. https://doi.org/10.1002/nop2.53

Massey, D., Chaboyer, W., & Anderson, V. (2016). What factors influence ward nurses' recognition of and response to patient deterioration? An integrative review of the literature. *Nursing Open*, *4*(1), 6–23. https://doi.org/10.1002/nop2.53

McGaghie, W. C., Barsuk, J. H., & Wayne, D. B. (Eds.). (2020). *Comprehensive healthcare simulation: Mastery learning in health professions education* (1st Ed.). Springer International Publishing. https://doi.org/10.1007/978-3-030-34811-3

McGrath, J. L., Taekman, J. M., Dev, P., Danforth, D. R., Mohan, D., Kman, N., Crichlow, A., & Bond, W. F. (2017). Using virtual reality simulation environments to assess competence for emergency medicine learners. *Academic Emergency Medicine*, 25(2), 186–195. https://doi.org/10.1111/acem.13308

Morgan, D. L. (1997). *Focus groups as qualitative research* (2nd Ed.). Sage Publications.

NCBSN. (2021). NCBSN Guiding Principles. National Council for State Boards of Nursing. Retrieved March 13, 2021, from https://www.ncsbn.org/1325.htm

Noble, H., & Smith, J. (2015). Issues of validity and reliability in qualitative research. *Evidence Based Nursing*, *18*(2), 34–35. https://doi.org/10.1136/eb-2015-102054

Padilha, J., Machado, P., Ribeiro, A., Ramos, J., & Costa, P. (2019). Clinical virtual simulation in nursing education: Randomized controlled trial. *Journal of Medical Internet Research*, 21(3), 1–9. https://doi.org/10.2196/11529

Padilla, R. M., & Mayo, A. (2018). Clinical deterioration: A concept analysis. *Journal of Clinical Nursing*, 27(7-8), 1360–1368. https://doi.org/10.1111/jocn.14238

Polit, D. F., & Beck, C. T. (2017). *Nursing research: Generating and assessing evidence for nursing practice* (10th Ed.). Wolters Kluwer Health.

Price, B. (2002). Laddered questions and qualitative data research interviews. *Journal of Advanced Nursing, 37*(3), 273–281. https://doi.org/10.1046/j.1365-2648.2002.02086.x

Prion, S., & Haerling, K. (2020). Evaluation of simulation outcomes. *Annual Review of Nursing Research*, 39(1), 149–180. https://doi.org/10.1891/0739-6686.39.149

Saldana, J. (2016). *The coding manual for qualitative researchers* (Third Ed.). SAGE Publications Ltd.

Salsberg, E. (2018). Changes in the Pipeline of New NPs and RNs: Implications for Health Care Delivery and Educational Capacity. Health Affairs Blog. Retrieved March 10, 2021, from https://www.healthaffairs.org/do/10.1377/hblog20180524.993081/full/

Samadbeik, M., Yaghoobi, D., Bastani, P., Abhari, S., Rezaee, R., & Garavand, A. (2018). The Applications of Virtual Reality Technology in Medical Groups Teaching. *Journal of Advances in Medical Education & Professionalism*, 6(3), 123–129.

Sanchez, A., Barreiro, J. M., & Maojo, V. (2000). Design of Virtual Reality Systems for Education: A Cognitive Approach. *Education and Information Technologies* 5:4, 5(4), 345–362. https://doi.org/10.1023/A:1012061809603

Sankey, C. B., McAvay, G., Siner, J. M., Barsky, C. L., & Chaudhry, S. I. (2016). "Deterioration to door time": An exploratory analysis of delays in escalation of

care for hospitalized patients. *Journal of General Internal Medicine*, 31(8), 895–900. https://doi.org/10.1007/s11606-016-3654-x

Shorey, S., & Ng, E. (2021). The use of virtual reality simulation among nursing students and registered nurses: A systematic review. *Nurse Education Today*, 98, 104662. https://doi.org/10.1016/j.nedt.2020.104662

Simmons, B., Lanuza, D., Fonteyn, M., Hicks, F., & Holm, K. (2003). Clinical reasoning in experienced nurses. *Western Journal of Nursing Research*, 25(6), 701–719. https://doi.org/10.1177/0193945903253092

SimX. (2020, November 19). About SimX [Video]. YouTube. https://youtu.be/TiaD1MA25ec

Sitterding, M. C., Raab, D. L., Saupe, J. L., & Israel, K. J. (2019). Using artificial intelligence and gaming to improve new nurse transition. *Nurse Leader*, 17(2), 125–130. https://doi.org/10.1016/j.mnl.2018.12.013

Spradley, J. P. (2016). *The ethnographic interview* (1st Ed.). Waveland Press, Inc.

Struyf, T., Deeks, J. J., Dinnes, J., Takwoingi, Y., Davenport, C., Leeflang, M., Spijker, R., Hooft, L., Emperador, D., Dittrich, S., Domen, J., Horn, S. A., & Van den Bruel, A. (2020). Signs and symptoms to determine if a patient presenting in primary care or hospital outpatient settings has covid-19 disease. *Cochrane Database of Systematic Reviews*, 7(7). https://doi.org/10.1002/14651858.cd013665

Texas BON. (2021). Texas Board of Nursing: Rule 217.11. Retrieved March 13, 2021, from

University of Nebraska at Omaha. (2020, February). *Conduct Successful Interviews with Faculty Candidates*. Www.unomaha.edu. Retrieved March 24, 2021, from https://www.unomaha.edu/academic-affairs/faculty-support/video-interview-tips.docx

Vincent, J.-L., Einav, S., Pearse, R., Jaber, S., Kranke, P., Overdyk, F. J., Whitaker, D. K., Gordo, F., Dahan, A., & Hoeft, A. (2018). Improving detection of patient deterioration in the general hospital ward environment. *European Journal of Anaesthesiology*, 35(5), 325–333. https://doi.org/10.1097/eja.0000000000000798

Wang, R., DeMaria, S., Goldberg, A., & Katz, D. (2016). A systematic review of serious games in training health care professionals. Simulation in Healthcare: *The Journal of the Society for Simulation in Healthcare*, 11(1), 41–51. https://doi.org/10.1097/sih.0000000000000118

Waxman, K., & Telles, C. L. (2009). The use of Benner's framework in high-fidelity simulation faculty development. *Clinical Simulation in Nursing*, 5(6), e231–e235. https://doi.org/10.1016/j.ecns.2009.06.001

Wayne, D. B., Didwania, A., Feinglass, J., Fudala, M. J., Barsuk, J. H., & McGaghie, W. C. (2008). Simulation-based education improves quality of care during cardiac arrest team responses at an academic teaching hospital. *Chest*, 133(1), 56–61. https://doi.org/10.1378/chest.07-0131

Weiß, S., Bongartz, H., Boll, S., & Heuten, W. (2018). Applications of Immersive VR in Nursing Education. *Zukunft der Pflege - Innovative Technologien für die Pflege*.

Whittemore, R., Chase, S. K., & Mandle, C. (2001). Validity in qualitative research. *Qualitative Health Research*, 11(4), 522–537. https://doi.org/10.1177/104973201129119299Zoom. (2021).

Xu, J. (2016). Toolbox of teaching strategies in nurse education. *Chinese Nursing Research*, *3*(2), 54–57. https://doi.org/10.1016/j.cnre.2016.06.002

Zackof, M. W., Lin, L., Israel, K., Ely, K., Raab, D., Saupe, J., Klein, M., & Sitterding, M. (2020). The Future of Onboarding Implementation of Immersive Virtual Reality for *Nursing Clinical Assessment Training*. *Journal for Nurses in Professional Development*, *36*(4), 235–240. *https://doi.org/10.1097/NND.0000000000000629*

Zoom Help Center. Zoom Video Communications. Retrieved March 10, 2021, from https://support.Zoom.us/hc/en-us/articles/201362683-Network-firewall-or-proxy-server-settings-for-Zoom

Appendix A

Approval Forms and Study Documents

IRB Approval

UTHealth
The University of Texas
Health Science Center at Houston

Committee for the Protection of Human Subjects

Dr. Ladonna Christy
UT-H - School of Nursing

April 12, 2021

HSC-SN-21-0282 - *Perceptions of Integrating Immersive Virtual Reality Simulation as a Teaching Methodology in a Hospital Setting*

The above named project is determined to qualify for exempt status according to 45 CFR 46.101(b)

***CATEGORY #2** : Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless:*

a. information obtained is recorded in such a manner that human subjects cannot be identified, directly or through identifiers linked to the subjects; AND ,

b. any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, or reputation.

(NOTE: The exemption under Category 2 DOES NOT APPLY to research involving survey or interview procedures or observation of public behavior when individuals under the age of 18 are subjects of the activity except for research involving observations of public behavior when the investigator(s) do not participate in the activities being observed.)

CHANGES: Should you choose to make any changes to the protocol that would involve the inclusion of human subjects or identified data from humans, please submit the change via iRIS to the Committee for the Protection of Human Subjects for review.

INFORMED CONSENT DETERMINATION:
Waiver of Documentation of Informed Consent

INFORMED CONSENT: When Informed consent is required, it must be obtained by the PI or designee(s), using the format and procedures approved by the CPHS. The PI is responsible to instruct the designee in the methods approved by the CPHS for the consent process. The individual obtaining informed consent must also sign the consent document. Please note that only copies of the stamped approved informed consent form can be used when obtaining consent.

HEALTH INSURANCE PORTABILITY and ACCOUNTABILITY ACT (HIPAA):
Exempt from HIPAA

STUDY CLOSURES: Upon completion of your project, submission of a study closure report is required. The study closure report should be submitted once all data has been collected and analyzed.

Should you have any questions, please contact the Office of Research Support Committees at 713-500-7943.

D-2 Form Approval

UTHealth The University of Texas Health Science Center at Houston
Cizik School of Nursing

Approval Form D-2

APPROVAL OF DOCTORAL DISSERTATION PROPOSAL

Student Principal Investigator: __Ladonna Christy_____

Title of Study: __ Perceptions of Integrating Immersive Virtual Reality Simulation as a Teaching Methodology in a Hospital Setting

---

This research proposal has been reviewed and approved by the Principal Investigator's Dissertation Committee.

Committee Chair: Melanie McEwen Date: 4/6/2021

Committee Members: Amy Franklin Date: 04/06/2021

Madlind J. Hoffman Date: 4-6-2021

_____ Date: _____

Dissertation Committee Recommendation:

_____x_____ Approval

_____ Approval with Reservations

_____ Disapproval

Original to Associate Dean for Academic Affairs; Copy to Chair, Committee members, and IRB(s)

Sociodemographic Questionnaire

Participant Identifier Code _____ **(**for researcher only)

Participant Initials _____

I. ROLE

a. Nurse Educator
b. Simulation Specialist
c. Education Leader (Director, Manager, Supervisor)

Please fill out the form below to the best of your knowledge.

II. AGE

What is your age group?

i. 20-25
ii. 26-30
iii. 31-35
iv. 36-40
v. 41-45
vi. 46-50
vii. 51-55
viii. 56-60
ix. 61-65
x. > 65

III. Education

a. What is the highest level of education you have completed? (select all that apply)

i. Associate Degree in Nursing
ii. Associate Degree other than Nursing
iii. Baccalaureate in Nursing
iv. Baccalaureate other than Nursing

v. Master's Degree in Nursing

vi. Master's Degree other than Nursing

vii. Doctorate in Nursing

viii. Doctorate other than Nursing

IV. Employment Status

a. Full time

b. Part time

c. Per Diem (PRN)

V. Ethnicity

a. White

b. Hispanic or Latino

c. Black or African American

d. Native American or American Indian

e. Asian / Pacific Islander

f. Other

VI. Years of experience as a nurse

a. 2 years of experience

b. 3-5 years of experience

c. Greater than 5 years of experience (please specify number of years)

_____

VII. Years of experience in the educator title/role you currently work in?

a. 2 years of experience

b. 3-5 years of experience

c. Greater than 5 years of experience (please specify number of years)

_____

VIII. How long have you used a form of simulation as a training methodology?

a. Less than 6 months

b. 6 months to a year

c. 1 year

d. 2 years

e. Greater than 2 years

IX. What form of simulation do you have experience with (check all that apply)?

a. Task trainers/low fidelity simulation

b. High fidelity simulation

c. Virtual reality simulation

d. Other (please describe)

_____

X. What form of virtual reality do you have experience with? (check all that apply)

a. Using virtual reality equipment using headset and handheld devices/electronic gloves for gaming or personal use

b. Using Virtual Reality using headset and handheld devices/electronic gloves to train nursing staff

c. Using Virtual reality on a computer with screen-based interactivity for gaming or personal use

d. Using virtual reality on a computer with screen-based interactivity for the to train nurses

e. Other (please describe)

_____

XI. What type of hospital setting do you work in? (check all that apply)

a. Teaching hospital

b. Nonprofit organization

c. For-profit organization

d. Less than 500 beds

e. Greater than 500 beds

f. Rural Hospital

g. Community Hospital

Verbal Script

Invitation to Take Part in Research

Study Title:	Perceptions of Integrating Virtual Reality Simulation as a Teaching Methodology in a Hospital Setting
Principal Investigator:	LaDonna Christy, PhD student, Cizik School of Nursing UT Health Houston
IRB Number:	HSC-SN-21-0282

"Good morning/afternoon, my name is LaDonna Christy, and I am a doctoral student at the Cizik School of Nursing at UT Health Houston. I am reaching out to you concerning your interest in the research study. This study is designed to learn more about barriers to integrating a virtual reality simulation program in the hospital setting for newly licensed nurses to teach them how to manage deterioration. I have a couple of questions to ensure that you meet criteria, and I can answer any questions you have at this time."

"The qualifications to be a part of this study include nurses with 2 years' experience in a hospital setting as a nursing educator, a nursing leader in a hospital education department of work as a simulation specialist. Do you have any experience with using simulation, work in a hospital, and participate in training newly licensed nurses? It is not required that you have any experience with virtual reality simulation."

"At this time do you have any questions for me?"

[Inclusion criteria will then be assessed. If the inclusion criteria are not met, then the PI will thank the interested participant for their time and inform them that they do not

meet criteria for the study. If the participant meets the inclusion criteria, the PI will inquire if the potential participant would like to take part in the study. If the participant says no, then the PI will thank the participant for their time. If the participant says yes, then the PI will continue the rest of the script].

"Thank you for agreeing to be a participant in the study. I will determine a time and date convenient to hold the interview(s). There are a total of two interviews that will be conducted for this study: an individual and a group interview. You will have the choice to participate in the group and/or individual interview. While it is not required for you to participate in both interviews, you may be asked to participate in both interviews as the information of this study will add to the science regarding integration of virtual reality simulation into the newly licensed' nurses training."

"All group and individual interviews will be conducted over 1-hour virtually using Zoom, with 3-4 participants per session. You will receive an email calendar invite with the link and passcode to the interview, a unique screen name with a 2-digit code, and instructions on how to change their screen name in the Zoom environment, to increase confidentiality. At the start of the interview, you will be placed in a waiting room until you can be identified by the principal investigator, through the use of the screen name and 2-digit code provided in the calendar invite. The 2-digit code will also be linked to the sociodemographic form." "Once you enter the interview, you will receive an audio notification when the recording starts, and I will confirm your verbal consent for the recording.

"The group interview will be composed of several nurse educators, hospital education leaders, and simulation specialists providing their knowledge, perceptions,

thoughts, ideas, and attitudes concerning virtual reality simulation and integrating the teaching methodology to train and teach graduate nurses in the management of clinical deterioration." The group and individual interviews will take approximately one hour. A $10.00 amazon card will be sent via email after your participation in the group interview; you will receive a $10.00 amazon card via email after the completion of the individual interview."

"All thoughts, ideas, personal experiences are encouraged to be shared. I will be asking several questions concerning information on this subject. In addition, you are welcome to share any additional information that you may have, expressed within the group interview, or separate individual interview."

"We will be careful to keep your information confidential and we will ask you and all the group members to keep the discussion confidential as well. Please keep in mind that you will be asked to turn on your video camera as a requirement for the study. All individual and group interviews will be video/audio recorded with your permission. You do not have to share any information that you are not comfortable sharing. You can stop the participating in conversation at any time. Any notes, recordings, or transcriptions will be kept private by LaDonna Christy, principal investigator. Any digital files will be encrypted, and password protected. Upon entering the group interview, the principal investigator will change your name to a unique name along with a 2-digit code."

"While no risks are anticipated, participants of this study may experience anxiety because they are invited to sort through their own ideas about perceptions of educational strategies in a group setting. Although the interviews are anticipated to last 60 minutes or less, you may become tired during the interview. You will be provided a break if needed

from the interview, or an option to reschedule. Please keep in mind that your information is private and confidential, and you will have the right to withdraw from the study at any time. Every effort will be made to protect your privacy and confidentiality by assigning a unique participant code that will only be identifiable by the researcher."

"Increased knowledge and the development of improved nursing educational strategies are examples of potential benefits. The findings from this study may benefit future educational efforts in improvement of training platforms for nurses that work with patients."

"No funding exists at this time for the research study, meaning that this study is not sponsored by any vendor or organization."

"Participation in this study is completely voluntary. You do not have to be in this study if you do not want to be. Refusing to participate will involve no penalty or loss of benefits to which you are otherwise entitled."

If you have any complaints, suggestions, or questions about your rights as a research volunteer, you may contact the UTHealth Committee for the Protections of Human Subjects (CPHS) at 713-500-7943. If you have any questions regarding the study, you may contact LaDonna Christy, principal investigator at (281) 889-6257.

Group Interview Guide and Questions

1. Introduce the purpose of the study (i.e., my name is LaDonna Christy, I am a PhD student at the University of Texas Health Science Center in Houston. I am seeking to gain more knowledge about perceptions and ideas you may have about Fully Immersive Virtual Reality Simulation and how it can be integrated in hospital training for newly licensed nurses, for managing deteriorating patients).
2. Inform the participants that the interviews are private and confidential and will be recorded via Zoom and will be used for research purposes only: receive 2nd verbal consent (1st to be obtained during recruitment script). Inform the participants the expectation is to keep all conversation and interaction with the group confidential.
3. Inform the participants that notes will be taken during the study to ensure the interviewer understands what the participants are saying, and they will be asked to turn on their video so that the PI can observe the participants and interactions.
4. Inform the participants that at the end of the group interview, a monetary compensation will be sent to the participants email after the completion of the interview.

Introduction and General Questions

"Thank you for agreeing to take part in this study. You may have a lot of experience with simulation and virtual reality, or limited experience with simulation and virtual reality so I will start the interview with asking some questions about what technology you currently use in your educational programs, if any.

1. How many graduate nurses/newly licensed nurses does your organization employ on an annual basis?
2. What type of simulation do you use in your organization to train nurses?
3. What type of training was provided to ensure your department had the knowledge to use it? Or did you learn it on your own?
4. How did the nursing staff, to include newly licensed nurses learn how to train on it? Did they have any barriers adapting to it if it was new to them?
5. If you are not using some form of simulation, can you provide some examples of why it hasn't been integrated?
6. Currently, how do you train them to "think" through clinical scenarios? Specifically, with a patient that is potentially deteriorating. (cognitive/clinical reasoning) (A newly licensed has limited cognitive/clinical reasoning skills. At this stage, they are able to identify what they see in a patient but are not sure what to do with the information).

a. How well is it working?

User Perceptions

For purposes of the study, I will provide a short video about fully immersive virtual reality simulation. As a disclaimer, this video serves as an introduction to familiarize the group to virtual reality simulation- the thoughts expressed in the video do not necessarily represent the researcher's thoughts or perceptions" https://youtu.be/HtY1MC9Ir8E (SimX, 2020).

1. What challenges or opportunities do you think would exist to integrating virtual reality simulation to train graduate nurses how to manage clinical deterioration in the hospital setting?

a. (probing) Tell me more about what makes them challenges? Opportunities?

2. If you were able to use this program, how well would it be adapted in the education department? Why or why not?

   i. (Probing, optional) If there was any pushback, what were your perceptions about the underlying issues? Learning curves?

   b. (Probing) How would these learning curves be best managed?

Source Knowledge

1. With what you currently know about newly licensed nurses, do you perceive any gaps they would have to using this technology? Why or why not?
2. How do you think using virtual reality could affect their ability to think through and act on a declining patient? (cognitive/clinical reasoning)

   a. (Probing, optional) Can you tell me more about this?

Real Environment

1. What type of space do you think you would need to provide fully immersive VRS training to newly licensed nurse's management of clinical deterioration?
2. What space do you currently have that will assist in adopting this technology?

Materials

1. In addition to fully immersive VRS simulation equipment needed to run the scenario, what other materials and resources would you need to make the learning successful for newly licensed nurses?

   a. (Probing) Technology resources?

   b. (Probing) Human/financial resources?

2. Who are the stakeholders involved to adapt and support this technology?

System Development/Educational VR System

a. If given a chance to integrate this technology to train newly licensed nurses how to manage a clinically deteriorating patient in your hospital, how would you evaluate if it worked or not worked?

2. Is there anything else you would like to share?

Individual Interview Guide and Questions

1. Introduce the purpose of the study (i.e., my name is LaDonna Christy, I am a PhD student at the University of Texas Health Science Center in Houston. I am seeking to gain more knowledge about perceptions and ideas you may have about Fully Immersive Virtual Reality Simulation and how it can be integrated in hospital training for newly licensed nurses, for managing deteriorating patients).
2. Inform the participants that the interviews are private and confidential and will be recorded via Zoom and will be used for research purposes only: receive 2nd verbal consent (1st to be obtained during recruitment script). Inform the participants the expectation is to keep all conversation and interaction with the group confidential.
3. Inform the participants that notes will be taken during the study to ensure the interviewer understands what the participants are saying, and they will be asked to turn on their video so that the PI can observe the participants and interactions.
4. Inform the participants that at the end of the group interview, a monetary compensation will be sent to the participants email after the completion of the interview.

Introduction and General Questions

"Thank you for agreeing to take part in this study. You may have a lot of experience with simulation and virtual reality, or limited experience with simulation and virtual reality so I will start the interview with asking some questions about what technology you currently use in your educational programs, if any.

1. How many graduate nurses/newly licensed nurses does your organization employ on an annual basis?
2. What type of simulation do have experience with?
3. How did you learn how to use it? Was there some type of formal training given to you? Or did you learn it on your own?
4. How did the nursing staff, to include newly licensed nurses learn how to train on it? Did they have any barriers adapting to it if it was new to them?
5. If you are not using some form of simulation, can you provide some examples of your perception of why it hasn't been integrated?
6. I am going to give you two phrases- please tell me what comes to your mind: newly licensed nurse, and clinical reasoning?
7. Currently, how do you train them to "think" through clinical scenarios? Specifically, with a patient that is potentially deteriorating. (cognitive/clinical reasoning) (A newly licensed has limited cognitive/clinical reasoning skills. At this stage, they are able to identify what they see in a patient but are not sure what to do with the information). How well is it working?

User Perceptions

For purposes of the study, I will provide a short video about fully immersive virtual reality simulation. As a disclaimer, this video serves as an introduction to familiarize the group to virtual reality simulation- the thoughts expressed in the video do not necessarily represent the researcher's thoughts or perceptions" https://youtu.be/HtY1MC9Ir8E (SimX, 2020).

1. What challenges do you think you would face integrating VRS into training the newly licensed nurses to think and act through managing a clinically deteriorating patient?
2. If you were able to use this program, how well would it be adapted in the education department? Why or why not?
    i. (Probing, optional) If there was any pushback, what were your perceptions about the underlying issues? Learning curves?

b. (Probing) How would these learning curves be best managed?

Source Knowledge

1. With what you currently know about newly licensed nurses, do you perceive any gaps they would have to using this technology? Why or why not?
2. How do you think using virtual reality could affect their ability to think through and act on a declining patient? (cognitive/clinical reasoning)
    a. (Probing, optional) Can you tell me more about this?

Real Environment

1. What type of space do you perceive you would need to provide fully immersive VRS learning to newly licensed nurse's management of clinical deterioration?

Materials

1. In addition to fully immersive VRS simulation equipment needed to run the scenario, what other materials and resources would you need to make the learning successful for newly licensed nurses? (Human? Financial? Technology?)
2. What is your perception of who the stakeholders are involved to adapt and support this technology?

3. What are some examples of conversation you with have with the leaders that would help approve your request to integrate and adapt VRS to train the newly licensed nurse to manage clinical deterioration?

System Development/Educational VR System

3. If given a chance to integrate this technology to train newly licensed nurses how to manage a clinically deteriorating patient in your hospital, how would you evaluate if it worked or not worked? (Evaluation of cognitive/clinical reasoning)
4. Is there anything else you would like to share?

Recruitment Flyer

Are you a nurse educator, nurse leader over an education department or a nurse simulation specialist with two years experience in the hospital setting?

If so, you may qualify to take part in a qualitative research study.

The purpose of the study is to explore perceptions of virtual reality as a teaching methodology for newly licensed nurses to learn management of clinical deterioration.

Benefits may include integrating improved nursing educational strategies for newly licensed nurses.

Risks may include: Fatigue or uncertainty of discussing perceptions of VRS integration in the hospital setting

This research study will be conducted virtually by:
LaDonna Christy, Principal Investigator, Doctoral Student, UTHealth Cizik School of Nursing

For more information please contact:
LaDonna Christy, Principal Investigator
Phone: (281) 889-6257
Email: ladonna.y.Christy@uth.tmc.edu

MANUSCRIPT

PERCEPTIONS OF INTEGRATING IMMERSIVE VIRTUAL REALITY SIMULATION AS A TEACHING METHODOLOGY IN A HOSPITAL SETTING

A DISSERTATION MANUSCRIPT

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS

FOR THE DEGREE OF DOCTOR OF PHILOSOPHY IN NURSING

THE UNIVERSITY OF TEXAS HEALTH SCIENCE CENTER AT HOUSTON

CIZIK SCHOOL OF NURSING

BY

LADONNA CHRISTY PHD(C), RN, NEA-BC, CCRN-K, NPD-BC, CHSE

MAY, 2022

Abstract

Introduction

As newly licensed nurses enter the workforce with limited experience and limited clinical reasoning skills, nursing educators must employ innovative strategies to teach graduate nurses how to identify and manage clinical deterioration – skills which are vital to saving lives and improving outcomes. Fully immersive Virtual Reality (VR), (also defined as Immersive VR) is one effective educational strategy available for hospital educators to use for preparing newly licensed nurses to recognize and manage clinical deterioration.

Objective

The purpose of this study was to explore perceptions of hospital-based nurse educators, simulation specialists, and nursing leaders with respect to integrating immersive VR to teach management of clinical deterioration to newly licensed nurses. The primary goal of this study was to assess the facilitators and barriers associated with integrating immersive VR.

Methods

A generic qualitative descriptive approach employing group and individual interviews was undertaken using purposive sampling of experienced hospital nursing educators, nurse simulation specialists and education department administrators. Data were analyzed using thematic analysis.

Results

Fifteen individual and one group interview were conducted using semi structured interviews. Participants indicated that use of immersive VR for educating newly licensed

nurses could prove successful in their organizations if they had the proper resources, time to learn and develop the training modalities, create scenarios that were relevant to the learner's needs, and financial/logistical support from the organization's stakeholders.

Conclusion

Immersive VR may be an effective pedagogy for educating newly licensed nurses on managing clinical deterioration if sufficient resources are in place for its' support.

Keywords: immersive virtual reality, hospital education, VR, nurse educator, simulation

Letter to the Editor

Dear Clinical Simulation in Nursing,

I am writing to you in reference to a research study manuscript we have prepared entitled *Perceptions of Integrating Immersive Virtual Reality Simulation as a Teaching Methodology in a Hospital Setting.* This paper has not been previously published and is not currently under consideration by another journal, and all authors have approved and agreed to submit the manuscript to this journal.

The principal investigator of the study has over 11 years' experience in nursing education in a hospital setting, 6 years' experience as a simulation specialist, carries a certification in Nursing Professional Development (NPD-BC), and a certification in healthcare simulation (CHSE). The principal investigator has also opened two simulation centers, with implementation of immersive virtual reality for the learners in a large academic medical center setting.

Virtual reality has been researched as a teaching methodology in medicine and nursing at the academic level, but limited studies have identified the use of virtual reality in hospital settings and its effectiveness. The aims of this generic, qualitative descriptive approach using purposive sampling were to explore the nurse educator, nurse simulation specialist, and nursing education department leader's perceptions of integrating immersive virtual reality simulation programs in the hospital setting for newly licensed nurses to teach management of clinical deterioration. Our findings indicate that in order to successfully implement immersive virtual reality in the hospital setting, stakeholder buy-in, development of relevant deterioration conditions, dedicated training and appropriate human and financial resources need to be available.

We agree the manuscript is relevant for The Clinical Simulation in Nursing Journal as immersive virtual reality may need to be one of several primary experiential pedagogies as the COVID-19 pandemic is continuing to evolve, making social distance practice a commonality.

There are no conflict of interests to report for this study. In addition, this study received no financial support. We would appreciate your consideration for publication.

Thank you again,

LaDonna Christy, PhD(c), RN, NEA-BC, CCRN-K, NPD-BC, CHSE

Introduction

In the acute care hospital setting, identifying the signs of clinical deterioration in patients is crucial to saving lives and improving outcomes (Agency for Healthcare Research and Quality, 2019). Missed opportunities in detecting the early signs of clinical deterioration cause a delay in the management of care (Vincent et al., 2018). These failure to rescue cases can lead to ICU admissions and subsequent death of patients (Sankey et al., 2016). As of 2019, the reported national average rate for failure to rescue was 13.9 % in post-surgical patients with treatable conditions; equating to unnecessary deaths, extended hospital stays and suboptimal outcomes (Agency for Healthcare Research and Quality, 2019). Further, given the novel corona virus's potential to escalate rapid worsening of patients, early intervention and management of clinically deteriorating patients by nursing staff is key. These demands emphasize hospitals' need for immediate strategies for remediation of clinical deterioration to improve patient outcomes (Anton et al., 2021; Nordick, 2020).

Experience of the bedside nurse plays a key role in the identification and management of clinical deterioration; this is limited in newly licensed nurses (Al-Moteri et al., 2019; White et al., 2021). To amplify the volume of experiences with clinical deterioration, immersive Virtual Reality (VR) provides an opportunity for an integrated, immersive, experiential pedagogy for newly licensed nurses, who are novice in clinical practice. Immersive VR is a specific type of learner-focused technological simulation platform that uses multi-sensory, 360-degree artificial environments to enhance the cognitive and reasoning skills in many professions – including health care (Sanchez et al., 2000; Weiß et al., 2018). With its multi-faced delivery system, immersive VR

promotes learning in cognitive, psychomotor, and affective domains simultaneously, and has been shown to significantly reduce time to train multiple concepts and objectives, leading to fewer errors in the clinical environment (Alfalah et al., 2017; Foronda et al., 2013; McGrath et al., 2017).

Use of immersive VR methodologies, however, relies heavily on the readiness and motivation of nurse educators to actively support and integrate this approach. In addition, leaders also play an integral part to supporting the adoption of innovative technological methods. In order to bring about long-lasting adoption, technologic transformations benefit from strong leadership support where leaders are skilled in "coordination and managing complexity in innovation processes," ensure implementation is structured over time to lessen the workload on those learning to use the technology and allow the end users to participate in the development of the training (Saghafian et al., 2021, p. 17). This top-down support is needed to evaluate VR's potential use and is necessary to facilitate adoption (Alfalah et al., 2017; Alfalah, 2018; McGrath et al., 2017a; Sitterding et al., 2019; Wang et al., 2016).

The purpose of this study was to explore nursing educators', nursing education leaders' and nursing simulation specialist(s)' perceptions of integrating immersive VR programs in a hospital setting. The primary aim of this study was to identify the facilitators and barriers for integrating immersive VR as a teaching methodology to train management of clinical deterioration to newly licensed nurses in the hospital setting.

Background

Timely analysis of evidence of worsening in a patient's condition starts with a nurse's identification of critical changes that may lead to clinical deterioration (Liaw et

al., 2011). Clinical deterioration is fundamentally expressed as the physiological movement from one clinical state to a worsened clinical state (Jones et al., 2013; Padilla & Mayo, 2018). Studies show that missed opportunities to detect early signs of clinical deterioration result in management of care to prevent further decline (Al-Moteri et al., 2019; Nordick, 2020; Vincent et al., 2018). (Nordick, 2020; Vincent et al., 2018). The delay in management of care of the declining patient may be the result of limited clinical reasoning skills, especially among newly licensed nurses (Anton et al., 2021; Forsberg et al., 2016; Nordick, 2020).

Clinical reasoning skills in nursing are defined as a "recursive cognitive process that uses both inductive and deductive cognitive skills to simultaneously gather and evaluate assessment data" (Simmons et al., 2003, p. 701). As such, the first step in the nursing process, the assessment of the patient, is reflective of clinical reasoning skills (Benner, 1984; Simmons et al., 2003). Clinical reasoning skills are generally under-developed in the newly licensed nurse due to limited experiences (Brown & Sorrell, 2017; Willman et al., 2020). In addition to time in practice, the use of immersive VR simulations has been shown to improve clinical reasoning skills by providing experiences in a safe, controlled environment (Forsberg et al., 2016).

In addition, the COVID -19 pandemic has further limited the most recent nursing cohorts' experiences in clinical practice due to changes in regulations which limited clinical rotations in their educational programs (Drenkard et al., 2021; Manakatt et al., 2021). Although many clinical rotations converted to desktop virtual reality and high-fidelity simulation to satisfy educational requirements, the simulations were used in lieu of – rather than addition to – onsite experiences (Badowski et al., 2021). Subsequently,

cohorts of newly licensed nurses face gaps in face-to-face experiential learning (i.e., working with actual patients to develop clinical reasoning and skills acquisition) (Fogg et al., 2020). As this population of nurses graduate and transition into the workforce, hospital educators need to fill the gap of training higher level concepts in which identification and management of the clinically deteriorating patient is critical for patient safety and successful patient outcomes (Massey et al., 2016). In consideration of the newly licensed nurse, these skills may be insufficient due to the limited experience of making patient care decisions at the bedside. Regardless of limited experience, the National Council for State Boards of Nursing (NCBSN) reports that the role of a nurse includes promoting safety and protection of the public while providing competent nursing care in all phases of nursing practice (NCBSN, 2021).

Immersive VR may serve as an important and innovative step in the education/learning continuum, and these technological advancements may prove an effective pedagogy to maturate clinical reasoning skills (Padilha et al., 2019). If combined with traditional training, immersive VR provides complementary experiential learning. When necessary, immersive VR can also supply rich, multi-dimensional opportunities to supplement face to face training.

Virtual Reality (VR)

There is some confusion regarding VR nomenclature (Cant et al., 2019). The VR environment has two overarching categories of delivery: “non-immersive” and “fully immersive” or “immersive” (Alfalah, 2018; Cant et al., 2019). Non-immersive VR involves screen-based learning; this sort of simulation depicts scenarios/skills on a computer screen (Cant et al., 2019). In contrast to non-immersive VR, immersive VR

provides an enclosed real-life replicated scenario using a head mounted display and handheld manipulated devices. This type of learning medium allows for incorporation of behavior, senses, emotions, and cognition to work through an integrated scenario using fewer resources (Cant et al., 2019; McGrath et al., 2017). Immersive VR incorporates haptic and cognitive training, in a highly consumable and usable format (McGrath et al., 2017). As such, immersive VR benefits include reduced costs, infrastructure, and a high degree of reliability in the training it provides (Abulfaraj et al., 2021; (Farra et al., 2015; Prion & Haerling, 2020). It extends beyond non-immersive VR and even high-fidelity simulation in many ways.

For example, learners who participate in immersive VR are provided with a more in-depth level of immersion and presence (Grassini et al., 2020; Radianti et al., 2020). Immersion and presence are key attributes to immersive VR technology (Alfalah, 2018; Grassini et al., 2020; Radianti et al., 2020). Indeed, VR provides the learner with an integrated level of immersion (i.e., the learner's interface with the VR application, as the user is fully immersed in the VR environment), and presence (defined as the full experience of immersion and feeling of being completely present using enclosure and integration of multimodal features such as images, sound, haptic feed-back and interaction), which is processed by the brain and understood as a coherent environment in which learners can perform activities and interact (Alfalah, 2018; Grassini et al., 2020). This can be a benefit to the learner as studies report the integration of immersion, presence, and interaction within the immersive VR environment lead to activation of additional neural pathways to improve memory mapping and more focused cognitive engagement (Makransky & Petersen, 2021; Petersen et al., 2022).

Despite general advantages of immersive VR for educational purposes, the usability of the software must be carefully evaluated. Usability in technology software implementation is defined as the "extent to which a system, product or service can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use" (Grassini et al., 2021, p. 157). Highly usable systems are more readily adopted and with reduced demands on the user, students are able to focus on the lessons (not the delivery system) (Zhang & Walji, 2011).

Another benefit to immersive VR includes the learner's ability to work through a fully immersive simulation autonomously, and to do so with a fraction of the cost of high-fidelity simulation. In comparison to high-fidelity physical simulation (i.e., mannequin-based simulation), VR is "relatively less expensive, requires fewer human resources to perform, and can be carried out in any setting" (Abulfaraj et al., 2021, p. 8). In fact, in an analysis of mannequin-based simulation versus VR, costs associated with mannequin-based simulations were over three times higher than VR ($36.55 per participant versus $10.89 per participant, respectively) (Haerling, 2018).

Immersive VR also provides an integrated training environment that allows for embedded, repetitive, automated learning. Immersive VR is fully automated which presents learning opportunities under the same set of conditions, replicated for each learner; this reliability and standardization in delivery may be less consistent in high-fidelity simulation, which depend on human instructors and teams to implement scenarios, potentially leading to scenario variation (Davis, 2009). In addition, studies report the need to develop and test more instruments in VR education for educators to devise innovative training approaches (Farra et al., 2015).

Finally, in the face of an unknown future in the current pandemic and beyond, immersive VR can also be used in the comfort and safety of the learner's home, under the remote guidance of an instructor, so that several learners can remotely participate in one immersive team-based clinical decision-making scenario (Coyne et al., 2018). Despite many advantages, examination of the efficacy of immersive VR is highly limited or even absent in nursing education literature. Therefore, there is a need to evaluate the effectiveness of immersive VR in nursing education to address how it can be used to integrate teaching concepts such as clinical reasoning skills (Aebersold, 2016; Madden et al., 2020; Samadbeik et al., 2018).

Theoretical Framework

The Educational VR System Model was selected as the theoretical framework to guide the analysis for this study. The initial conceptual VR framework model, developed by Sanchez et al., (2000) addressed the potential for VR to be a learning medium. As immersive VR evolved and became more readily available for use, Alfalah et. al. (2017) refined the model to ascertain if VR provides a useful framework when embedding VR technologies as a pedagogy into educational programs.

The model (Figure 1) includes the following concepts: 1) user perceptions – the students and instructors' perceptions towards adapting the technology, which is the foundation of the model; 2) source knowledge – all concepts, and skills, to be learned by the students; 3) real environment – teaching location and setting; 4) didactic materials and resources needed to implement the program; and 5) system development – the actual implementation of the VR system (Alfalah, 2018, p. 2640).

The model proposes that to successfully integrate VR methodologies, the usability originates with the perceptions of students and instructors to adapt to this technology (Alfalah et al., 2017; Alfalah, 2018). Although perceptions of the students in the model was identified by the authors as the first step to implementation, the first step in this study is the perception of the instructors (i.e., nurse educator groups); they serve as the primary drivers in healthcare organizations to strategizing, planning, developing, and facilitating conversations with the organizations' stakeholders to receive support and funding for current and future educational curricula modalities.

Methods

Design

A generic qualitative descriptive approach was used to explore the perceptions of hospital-based nursing educators, nursing education leaders and nursing simulation specialists regarding integrating immersive VR as a learning platform to train newly licensed nurses how to manage clinical deterioration.

Human Subject Review Approval and Recruitment

Approval for this project was obtained from The University of Texas Health Science Center's Committee for the Protection of Human Subjects institutional review board on April 12, 2021 (HSC-SN-21-0282). The study was deemed "exempt" and the need for written consent was waived.

Participants were purposively recruited by posting a flyer on the Society for Simulation in Healthcare, and the Association for Nursing Professional Development (education/simulation organizations websites), with prior approval. Potential participants who expressed an interest through email or voicemail were contacted by the PI, who

screened candidates per the inclusion criteria. Those who met the criteria were invited to take part in the individual and/or group interview which were conducted over 40-60 minutes. During the initial screening, the PI discussed the study details and answered participants' questions. A calendar invite was sent for the interview once the participant agreed to be in the study. Verbal consent was obtained before the start of the interview. A ten-dollar Amazon gift card was provided via email at the conclusion of the interview.

Sample and Setting

Participants selected for the study included English speaking nurse educators, nurse simulation specialists, and nursing leaders over education departments with two years' experience in a hospital setting. Participants also needed to have, had experience using some form of simulation and agreed to audio-video recording of the interviews. No subjects were excluded based on their knowledge of immersive VR, age, gender, race, or ethnic group. The interviews were conducted using web-based conferencing setting to ensure social distancing practices and allow for a larger range of participants located in different geographical areas.

Data Collection

Sociodemographic variables were collected before the start of the interviews via an encrypted electronic survey. A unique ID was assigned to the participants' interview and linked to the sociodemographics to maintain confidentiality. The letters L, E, SS and GI were assigned to the participants with a corresponding interview number (representing "Leader", "Educator", "Simulation Specialist", and "Group Interview" participant respectively).

Semi structured interview guides (individual and group) were developed with the assistance of the research team (Appendix A). The Educational VR System Model framework informed the structure and general topics within the interview guides. Interview questions explored facilitators and barriers of integrating immersive VR in the hospital setting including perceptions of adaptability as a learning medium, source knowledge, materials, real environment, and system development (see Figure 1) (Alfalah, 2018). The first two interviews, one a pilot group interview with four nursing educators who use simulation in their programs, and the second, an individual interview with a nursing leader in simulation education, provided the principal investigator (PI) feedback on the interview flow and questions.

With each subsequent interview, questions were iterative to address emergent or unexpectant themes and to improve the breadth and depth of the responses. All interviews were conducted by the PI from April to July 2021 via Zoom web-based conferencing. Interviews were conducted until saturation was achieved, seeing a redundancy in thematic content relevant to the aim of the study (Crabtree & Miller, 1999). All interviews were audio recorded and transcribed via Zoom. The PI reviewed the recordings and checked/revised the transcripts for accuracy.

Data Analysis

Thematic content analysis incorporating a 6-step process from Braun and Clark (2006) was used to analyze the data. The 6-steps include: 1) familiarizing oneself with the data; 2) assigning preliminary codes to describe the content; 3) searching for patterns or themes in the codes across the different interviews; 4) reviewing themes; 5) defining and naming themes; and 6) producing a report (Braun & Clarke, 2006, p. 87). MAXQDA

2020 (VERBI Software, 2020) was used to organize and manage the data. Data were analyzed during and after the interviews in a reflexive process, using bracketing for reflective notes to prevent bias and personal assumptions of the responses (Crabtree & Miller, 1999). The PI immersed in the data, listened, and reviewed the transcripts and recordings of each of the interviews multiple times to get a sense of what the participants were conveying, and wrote down reflective thoughts based on the responses and observations of participants. A journal was used to record the reflective notes and supplement the analysis process.

Data were coded using an inductive and deductive approach. Coding of the data involved assigning a word, and/or a short phrase that identified a "summative, salient attribute for a portion of language based or visual data" (Saldana, 2021, p. 5). A list of A priori codes were developed based on the theoretical framework and research aim (which targeted specific issues of integration the PI was pursuing) (Saldana, 2021). A codebook was employed to define the use of the codes during the analysis process. The codebook was initially developed with the A priori codes but remained an iterative descriptive manual of codes throughout the coding process. The first interviews were coded using a deductive approach with the assistance of the qualitative expert on the research team by assigning the A priori codes.

As the PI reread and reviewed the transcripts, several codes were recoded inductively as new data emerged from the responses, as inductive coding requires that the researcher be open-minded, allowing concepts and ideas to emerge from the data, thus "letting the data speak for itself" (Crabtree & Miller, 1999, p. 342). This process of inductive and deductive coding was ongoing and cyclical during the analysis phase, as

multiple rounds of listening to the recordings, coding, and recoding the interview data were completed to capture the thick descriptions of the participants. The PI met with the research team frequently to review coding schema and analysis process to confirm what was being seen in the data. In addition, the PI re-contacted a few participants to ask clarifying questions on key responses relevant to the aims.

Codes were then organized, collated, and placed into categories. Initial identification of themes that linked the codes were developed and reviewed with the research team. The PI created a thematic map that showed the relationship among the codes and themes, as well as the PI's reflective notes of responses of the participants. Initial themes and sub themes were reviewed by the research team in a peer debriefing. It was determined that several themes and subthemes needed additional review for clarity. Final themes and sub themes were organized and linked to the aim of the study (Table 3). The final list of themes with corresponding sub themes based on facilitators and barriers was reviewed and approved by the research team.

Results

Population Characteristics

A total of 15 individual interviews and one group interview were conducted for this study. The individual interviews included five leaders, seven nursing educators and three nursing simulation specialists. The group interview was conducted with five nursing educators. Nineteen female and one male were included in the study. The participants were located in acute care hospitals throughout the United States and Canada.

Differences Among Each Group of Participants

As seen in Tables 1 and 2, participants who were interviewed had an array of expertise in different hospital settings. Of note, 75% of the participants (n=15) had greater than five years of experience in the educational setting within the hospital, and 15% of participants (n=3) had greater than 10 years of experience in simulation. A comparison among the stakeholder groups can be seen in Table 2.

Themes

As depicted in Table 3, the themes identified in the study were: clinical reasoning skills of the newly licensed nurse, perceptions of adaptability of immersive VR, psychological safety, and organizational support and resources. A total of twelve sub themes were reflected in the main themes (Table 3). These are described below, and examples of participants' responses illustrate how they explained the perceived facilitators and barriers for implementing immersive VR in the hospital setting for training of management of deterioration for newly licensed nurses. Of note, during the course of the interviews, often as participants discussed a phenomenon, facilitators and barriers were reflected collectively in their responses.

Clinical Reasoning Skills of the Newly Licensed Nurse

A consensus among the participants' responses was that the newly licensed nurses' clinical reasoning skills are immature. Specifically, newly licensed nurses' clinical reasoning skills were described as: "missing" (E2), "lacking" (E7), "disconnected" (E5), "a gap" (L1), "it's clearly lacking" (SS1) and "not well developed" (L3). One participant identified that newly licensed nurses lack clinical decision making "because they lack the ability to make critical decisions based on their novice experience

level" (E4). Two participants provided more in-depth response, attributing the problems with reasoning skills to a lack of experience, or relying on book knowledge to make decisions. They noted:

I think some of our reasoning is something that comes with experience and time. I mean, I think, as a newly licensed nurse I think they have the, per se, book knowledge and they know what should be done in a perfect world, but I think when they're, they're with the patient, and it's not A, B and C, the way it should go, they don't really know how to switch their brain for the critical thinking, or the reasoning comes in (E3).

They don't have very much of it [clinical reasoning]. Okay, um you know, some of them retain the book knowledge better than others, but it's learning to apply it. They really need to learn it [clinical reasoning] and you really can't learn it without exposure. (SS2).

Clinical Deterioration User Cases for Clinical Reasoning Skills. The use of immersive VR for clinical deterioration scenarios were seen as a facilitator. This sub-theme supports context to encourage the development of software to provide content rich scenarios that integrate haptic skills and cognitive tasks to recognize and manage a deteriorating patient. Participants explained immersive VR could maximize time, provide a learning medium that could be conveniently repeated several times, and would support individualized needs of learners.

Participants had ideas on different aspects of deterioration scenarios and how to develop a user case that incorporated not only the skills needed to perform within the scenario, but the importance of interpretation of "why this is happening in the patient" (L1), to allow them to critically think their way through a patient intervention. One participant commented that immersive VR would be seen as more realistic than their

current practice of using high fidelity simulation: “They can actually even utilize the VR stethoscope and listen to lung sounds, listen to abdominal sounds, so they should be able to put the puzzle pieces together. That's what critical thinking really is and putting them together to formulate an idea of what's, what's [the] diagnoses and what are we going to need to do to help keep the patient from deteriorating.” (L5)

Participants commented on how immersive VR could be used in array of different clinical deterioration scenarios specifically designed for their areas. For example:

Even sometimes in the OR [operating room] I know it's a little different, but you do have some occasions where the patient may code. I think it would be very interesting to be able to work through getting them [newly licensed nurse] through an operating room situation.” (E5)

Okay, well, you could do any kind of scenario you wanted, you could have the open chest, right, in real time, you know right now it's impossible to do something like that, so you would definitely have unlimited ability to do different scenarios. (GI5)

Participants also identified that in order to implement immersive VR successfully, the newly licensed nurse would need to have already mastered basic nursing skills such as “starting and IV,” “drawing blood on a patient,” (E5) completing a basic physical assessment and “recognizing vital signs” (SS3) that may be an indicator that a patient is deteriorating. One explained:

So, in the [VR] simulation the assumption is that they know how to do that, it's really measuring that critical thinking, are they able to understand that the next step is to draw those labs . . . Sure, though it's, it's just kind of a compliment to, to the skill and the

critical thinking. But I think this is the piece that it enhances, the critical thinking, because we don't normally capture that piece. (L1)

One participant also mentioned that the technology could serve as a way to assist in capturing cues and interventions for patients with declining mental health disorders, as well as addressing user cases for newly licensed nurses who work in different areas of the hospital. In other words, the participant saw the value in implementing contextual scenarios based on each unit's patient population:

And so, in looking at the programs that were available for you know, patients with mental health disorders and how to interact with them- VR is really going to be that component that gives the whole product because it's so hard to simulate that even with providing dialogues. Still, that interaction can be difficult so that's why, you know, and looking at using VR, it really was a selling point for us because we, you know, we're not going to be able to create a whole simulation you know, for the facility with all the bells and whistles knowing how, how I still meet the needs of all the employee areas. (L5)

Perceptions of Adaptability of Immersive VR

As identification of the knowledge gap of the learner by the participants is of importance to support this pedagogy, participants also identified their own personal reflections of adaptability of immersive VR. In coordination with the conceptual model, participants were asked about their own personal thoughts of immersive VR as a learning method. Subthemes include perceptual bias of generations, technology adaptability and motivation, resistance to change, and efficiency.

Overall, responses were positive. Participants stated the opportunity to integrate immersive VR into their educational programs for newly licensed nurses as "fun," (E1),

(GI5), “cool” (L1), “super-exciting” (L3), “we should be utilizing this pedagogy” (E4), “I would really like to have virtual reality in our education” (SS1), and “I’m excited about it” (SS2). Three of the participants explained they had just started using immersive VR in their programs but were not using the technology specifically for newly licensed nurses. Several participants displayed their enthusiasm about implementing immersive VR in their hospital. Examples of comments were:

“Now this sounds very, very exciting” (E3)

“Really, I think it's exciting, and I think there's a lot of value to it” (E6)

“Um, I think it's a great innovative idea and hopefully my organization would be receptive to something like this” (E7)

“I think it's really valuable and I hope it becomes a more available resource, because I know it could make a lot of really positive changes in a short period of time” (SS3)

Perceptual Bias of Generations. Perceptual bias in generations includes the perception of the adaptability and usability of the technology based on the user’s age and/or generation. Examining the number of responses associated with age and adaptability of immersive VR, there was a bias among the interviewees associated with age and the ability to adapt the technology for training. In other words, facilitators and barriers were expressed simultaneously about use of this technology among nurses of all ages. In several interviews, participants felt the “older” educator (SS3, GI5, L5) and the more “seasoned nurse” (GI3, L2), would be a barrier to immersive VR implementation. In contrast, several participants stated generational differences were also reflective of facilitators among younger educators due in part to motivation, and willingness to adapt and learn the technology.

Example of participant's comments about age related barriers concerning older age and adaptability of the technology include:

I think our educators, are a little bit older maybe in their 50s, and so I don't know, I don't sense that they would be opened to trying this as a new pedagogy." (E4)

I think it's not going to be the new grad challenges it's going to be our staff, our current staff of seasoned nurses [educators] to get on board with this. I think, time will help that as the seasoned staff fall off. (GI1)

In another example, one participant, who had several years' experience as a nursing simulation specialist, inferred that the younger educators would adapt to immersive VR:

And I think, for the most part, all of, most of our educators are really excited about the technology and what to learn and want to advance this. Most of them are very young, in their education role so they're open to learning and trying new things. (SS2)

Thus, an underlying concept of age-related barriers may exist with this population. The perception reflected in the responses was that the older, "more seasoned" nurse may be unwilling to adapt to this technology. When asked to clarify the reason they perceived age to be a barrier to using and integrating immersive VR in their educational settings, participants conveyed the following:

I just think that the older generation didn't grow up using technology. In some instances, our older educators - over the age of 50 or so – still covet the ability to use a paper checklist, and do not like using our electronic learning management system. To get them to learn a whole new technology platform is going to be a big hurdle because they currently resist most forms of technology. (E4).

…We always get pushback when we want to implement a technological advancement and the younger educators are always ready to try something new. I think the older people in our department are just set in their ways and don't have any motivation to change. (GI1).

Interestingly, participants who had been in practice more than 20 years who provided positive comments about implementing immersive VR also expressed concern related to older educators and their perceived resistance to adoption of immersive VR in their departments. As none of the participants in any of the age categories stated any cause for fear or inability to learn and adapt the software, it was an unexpected finding that the concept of age-related barriers existed in this population.

These comments suggest that in order to implement immersive VR for new nurses, educators need to be motivated and to see a need to learn new technologies. As for the perceptions of the newly licensed nurse's ability to adapt to this technology, participants responded positively. Participants indicated that younger age, and previous experience with the technology would be a facilitator to the immersive VR's implementation. Thoughts included: "they would welcome it [VR] with open arms" (E3), and in the younger generation of nurses "it probably won't be that big of a translation" (E1). One participant noted that this technology would be "exciting" and an innovative platform to add for training, as what is currently being done in the setting may be outdated:

Depending on what generation you're dealing with, of course the younger generation, I think they would be ecstatic to be able to use it, because it's something different, and I

think we have to realize for education they're tired of the PowerPoints, they're tired of, I mean, like all of that stuff is almost obsolete. (E3)

Technology Adaptability and Motivation. In addition to age/generational differences, participants discussed the adaptability among the educator groups to implement immersive VR in their programs for newly licensed nurses. A participant with over 20 years of nursing experience and 2 years' experience using simulation in an educational setting stated her perception of implementing immersive VR may lie within the motivation to learn and adapt this technology:

I think, you have to have an open mind, personally, right now… I don't think its age related, I think it's more adaptability, open mindedness and willing to engage in something new. (E1)

Participants also described how comprehension of the technology was seen as both a facilitator and a barrier to immersive VR implementation. This was based on the motivation of the educator and their ability to overcome the learning gap:

So, I think it's the educator's understanding of the technology and the knowledge and how to use it, and comfort level. I think those can all be a benefit, but also can be a barrier depending on the individual. (E6)

Our educators are from an older generation, and so I think just basic computer skills is, is an area that we need improvement on so, I think, going to something like virtual reality, yes, definitely would be a learning curve, but I don't think it would be something we wouldn't be able to overcome. (SS1)

Resistance to Change. A leader over several education departments and a simulation lab for her organization reported that in in addition to age, resistant to changing pedagogies was identified as a barrier.

Sadly, you have some educators, that are okay with status quo and they just like what they're doing… "that's just more work and I'm going to have to train myself." You know, to me, so, so I think that that piece is, you're always going to have those naysayers that are very negative and that's just you know, are resistant to change. (L1)

To get a deeper understanding of the association of age and resistance to change, the PI re-contacted selected participants to gather additional insight on this phenomenon. One leader responded that generational differences did not play a major part in learning new technology, but that the key stressor was contextual, and the time given to adapt.

I don't think it's true that older people will not adapt to technology. For example, when we had a large rollout for EPIC [electronic health record system], the older educators were instrumental to making sure the staff were trained appropriately and they did a very good job of it once they identified that this was a need. I think that in the current environment we are changing things so fast that educators, and staff, are very stressed out because they don't have time to adjust to the changes. At the start of the COVID pandemic, I remember that we changed the PPE [personal protective equipment] policy four times in one week! That was a bit much for our staff and it left everyone severely stressed out and fearful. If we gave the educators appropriate time to learn and master the technology, I think they would be on board with this. (L4)

Efficiency. Participants identified that immersive VR could lead to more time efficient training for newly licensed nurses. It was noted that immersive VR could be

used to provide “more with less” (E6), and “expose them [newly licensed nurses] to a lot more and easily” (E1).

I think it’s also the opportunity to walk them through or have them go through a scenario and within a shortened timeframe, and potentially have them run through multiple scenarios versus just one or two in another use of technology. (E6)

I think, if you, if they're allowed to do it [immersive VR] a lot and go through different scenarios a lot, they'll be able to learn to start just connecting the dots. (GI3)

One participant commented on how immersive VR scenarios could be repeated several times in lieu of high-fidelity simulation to increase learning opportunities:

I don’t know how long the scenarios are, but it would be nice if they could run through them multiple times…in VR we can repeat them, and let’s go through that again, maybe we can get it right and see what we missed along the way. (GI4)

Further, participants commented on the ability to create multiple scenarios and run them simultaneously with the appropriate space.

“Of the individual learner, I think that's also one of the beauties, is that you could more than likely design scenarios where it’s specific for practice environments and you could have a multitude of them.” (E6)

“And I would like us to see having VR available for multiple, you know, simultaneous simulations. So, I’d like to be able to have VR in more than one room going at the same time.” (L5)

Another participant identified that exposure to repeated scenarios may assist in muscle memory when managing clinical deterioration:

And this, working through the process as they go through the snares and say oh, this is, I see this lab, and this is happening, and this was the outcome, and they start learning that clinical reasoning and critical thinking, whether they can work through those pieces, and I think that that can be developed virtually just through the practice of you know, strengthening that learning muscle to be able to get it. (GI3)

Psychological Safety

As participants expressed their enthusiasm about immersive VR, they also revealed the need to address and manage psychological safety to provide a safe space for the educators in their departments as well as for the newly licensed nurses to learn. Psychological safety is formally defined as "a feeling (explicit or implicit) within a simulation-based activity that participants are comfortable participating, speaking up, sharing thoughts, and asking for help as needed without concern for retribution or embarrassment" (Loprieto, 2013). Psychological safety is crucial to the success of simulation learning, and the foundation of the simulation environment application for learners. Within this perspective, participants conveyed the need to ensure psychological safety of the learner as well as the educator learning the pedagogy to use as a teaching tool. Given that VR technology is novel for most of the population sample, participants felt that using VR technology might have the tendency to showcase the knowledge gap of the educators using the technology, as well as the clinical reasoning knowledge gaps of the learners. Sub themes were identified as fear and vulnerability and providing a safe space to identify knowledge deficiencies.

Fear and Vulnerability. A leader who was interviewed discussed the history of her department and how implementing changes for the learners led to fear and

vulnerability of not being seen as the experts among her instructors. She described that anything newly implemented in her department leads to instructors feeling a loss of positional control and fear of being denounced. She described two concepts related to the instructors' gaps: 1) a gap in technology usage and 2) a gap in managing clinical deterioration which may be evident when training begins on a new product. She mentioned concerns regarding implementing VR in the hospital setting with instructors who have limited knowledge on how to operate the software and equipment, and/or how specific clinical deterioration scenarios could "showcase their vulnerabilities." Among the comments:

And this is, this is, you know virtual simulation, is kind of the same, the same thinking, as I think people get very scared. Especially seasoned nurses [educators] that you're going to find out that they're not as good as they think themselves to be, and I think that that makes them very vulnerable and so how we could do this in a way that doesn't you know, embarrass them, or make them feel less than it would be. (L1)

This participant went on to explain how it is important to identify strategies to maintain safety in this environment by managing comments and providing a safe place for everyone to learn. She provided a meaningful example of how to mitigate the fear factor for her instructors; this is seen as a facilitator:

Really you know, again, I think, as a leader you got to, you have to manage negative comments and control that this is just a learning resource that we all grow from…So, I think it'd be really nice if we just made it very user friendly and love on our educators, so that we don't see any vulnerabilities, but know that they're accountable for what that scenario is and just give them a run through, here's what the expectation is. Take a look at

it. Familiarize yourself with it, you're going to run through the scenario and then you know if you need to do a dry run with somebody before you actually have your new grads or your staff running through the scenario, then we could do something like that, but trying to make it as user friendly for them as well because I'm sure if you've never done it, [VR] you don't know how. (L1)

Providing a Safe Space to Identify Knowledge Deficiencies. A participant identified facilitators of immersive VR - in contrast to high-fidelity simulation – explaining that it identifies individualized weaknesses of learners:

So, I said it [VR] gives them the safe environment to be able to do that. It also allows, allows an individual to work through the process independently, to truly identify what their areas of opportunities are and what their strengths are so that you can really determine a plan that's individualized. Yes, you can do that with high fidelity simulation, but we also have a tendency to focus on the group dynamics in high fidelity simulation and therefore some people could slip through without really identifying their areas that they need to work on, if you're not very astute to what's happening or allowing others within the group to lead. (E6)

Organizational Support and Resources

While usability of immersive VR for clinical deterioration scenarios was seen as a facilitator to implement different aspects of clinical deterioration scenarios, organizational support and resources were identified both as a facilitator and barrier to implementing immersive VR. Subthemes included the stakeholders who would approve the program and its purchase, environmental context, cost, and space needed to facilitate the learning, the information technology (IT) infrastructure needed to run the program,

and the training time for the educators to learn the new technology. It is also important to note that several facilitators and barriers were identified that may affect the ability to implement immersive VR in the participants' organizations.

Stakeholders. Participants identified that stakeholders who needed to support the implementation of VR in their organizations included: "my director" and the "clinical operations person" (L2); the organization's "leadership" (SS1); the "CFO" (Chief Financial Officer) (SS3); the "director of education and the chief nursing officer, because it's their employees" (SS2); "physicians" (SS3); and the "COO [chief operating officer] of the campus, and much higher up within the system" (E5). A participant indicated that essentially everyone who uses the product, including "end users, unit, and education [leaders]" (E6) would be incorporative of stakeholders.

Environmental Context. Participants indicated that the COVID -19 pandemic and an increased number of changes in a short amount of time led to the need to be environmentally aware of what is going on in the organization. That would potentially pose a barrier to something else new being implemented:

I think when you talk about the pushback, that is just that you know, I think, especially with our staff in the current environment or they're very stressed and tired and every, with everything… so I think just adding another new type of technology that they have to try to grasp and learn, it is, I think, just an added stressor. (GI 3)

Space and Cost. Participants reported cost and space were elements of consideration to implementation of immersive VR in the hospital setting. Participants identified that "you just need a space big enough to maneuver your body around" (SS3), "you know just a fairly empty room" (SS2), and a "10 by 10" (E1). One participant

commented that a “padded room” (GI4) would be needed to ensure safety of the participants. One participant described that space may be a barrier to implementing this technology, but also can be seen as a facilitator if the right space was appropriated “to do [VR] without bumping into walls or other people.” (E1)

One participant believed that an alternative solution for space requirements needed within the hospital setting:

“In my opinion it's really at the, you know, the leisure of the students in their home environment, which is probably the best, most comfortable environment right versus a foreign environment (L1)

Cost was seen as a facilitator and barrier:

“The cost of the equipment is going to be your biggest element” (E6)

Because I’m a party of one, and I think financially, you know. I know that I would have the support because we've already talked through it, you know but that's always on the table with something that's a potential challenge - the financial. (L3)

A participant commented that cost may be a facilitator, as VR (in comparison to high fidelity simulation) would prove cheaper, with less needed human resources:

You would have to have, you know, have the money to afford the equipment, I would imagine you could buy a lot more VR than you could for one high fidelity [mannequin] system. Sure, so it might actually be cheaper, but there would be a cost on the initiation of it, and over the long term…and then you wouldn't need as much manpower, so that would definitely help with the costs for that. (E1)

A participant who currently uses VR in her educational programs conveyed that when she was having the conversations with the leadership team, a combination of cost

and space came up. She identified that the selling point for VR included the ability to have a teaching mechanism that could be flexible as opposed to asking for additional space.

To create a training suite is impossible, I mean the funding is ridiculous and you know, you can't really use the actual environment because of the cost, you know of having to clean and/or upkeep. I mean, just in shutting it down for training, it's just not feasible. So, for me, one of my big selling points was that I wanted the educators to have simulation that can be utilized to help train all departments and if I can't, if I can't create a simulation room, with everything that they need, how can I subsidize what I have so that we can create a realistic environment for them to train on. (L5).

Space was also seen as a facilitator by another participant:

I think one of the benefits of virtual reality is that you don't need all of the equipment you just need your headset and then you're able to manipulate so it's really just having an empty space that they're able to move around in. (SS1)

Internet and Software Infrastructure. Two of the participants stated the need to have the appropriate Internet capabilities to run the technology, including "ensuring there is appropriate Wi-Fi extenders and access points" (GI3), and the appropriate "IT infrastructure" (L1).

Dedicated Training Time. Dedicated training time was identified as a facilitator to immersive VR's success to implementation. Participants stated the need to ensure the educators would get the time necessary to train on the technology to be successful:

To ensure that your educators are well versed but remain well versed in [VR], depending on the program, depending on the group of professionals you're working with it would

require additional time and learning and so could that be a push back depending on current responsibilities. (E6)

"And then we need training with the educators letting them know, and learn to, you know, [use] the capabilities of it." (L2)

"The training, obviously" (SS2)

I think just putting the gloves and the glasses on and letting them, just like giving them a, just-stack these blocks, you know or something, just little snippets of snares where they can figure out how the headset and the hands coordinate. (E1)

This participant also commented that in addition to the educators, the newly licensed nurse may also benefit from training:

I think we make an assumption that all newly licensed nurses are coming with a foundation of embracing technology, know how to use technology effectively yeah. I think there's elements of technology that they truly maybe have a better grasp of. And some individuals don't, but I think virtual reality is very different than what we use currently and therefore I think we'd have to be prepared to provide additional time, hands on to learn the technology so that they get the best bang for the buck out of the learning experience. (E6)

Discussion

This is the first known study that examined facilitators and barriers to implementing immersive VR in the hospital setting among the study population. As mentioned, the author of the VR educational framework (Figure 1) indicated that it serves as a "useful reference framework for designing and embedding VR in any pedagogical program as an educational technology" (Alfalah, 2018, p. 2640). These findings of this

study support the framework and illustrate that implementing immersive VR in the hospital setting for newly licensed nurses involves considerations of: 1) the perceptions of adaptability - the educator's groups perceptions of adaptability of the pedagogy); 2) the source knowledge of the learners (i.e., the learner's baseline knowledge of management of clinical deterioration and applicability of clinical reasoning); 3) materials (which included support and organizational resources in this population); and 4) the setting of the teaching – which in this case is attributed to allocation of dedicated space. Additional concepts in the model (system development and educational VR system, respectively), could not be ascertained in this population as only three of the participants (n=15%) had actually implemented immersive VR in their organizations. It was also noted that the use of immersive VR was not specifically intended for the newly licensed nurse group.

Similar to results as seen in the conceptual model (Alfalah, 2018), the educator groups agreed that immersive VR would prove a beneficial learning platform to improve clinical reasoning skills. In other words, participants identified that a need exists to enhance training for managing clinical deterioration in the newly licensed nurse because of the limited experiences these new nurses have in prelicensure programs, coupled with their inexperience as a nurse, and that immersive VR could help meet this need. This can be further validated in the literature which reports that significant gaps in clinical reasoning in newly licensed nurses may be due in part to learner inexperience, as well as COVID-19 clinical restrictions in which minimal experiential learning opportunities were available (i.e., participating in bedside care) (Drenkard et al., 2021; Naciri et al., 2021; Rupley et al., 2020).

The concept of generational barriers in technology contrasts with the original framework study in which age was not identified as a barrier or facilitator to implementing immersive VR. However, this phenomenon has been seen in other studies. For example, a phenomenological, longitudinal study following teachers who had over 20 years of experience and were asked to implement newer technologies in their curricula found that: 1) resistance to change was directly correlated with time constraints and limited training of the technology, and 2) knowledge insecurities were related to students' and newer teachers' expertise with technology, causing a loss of position as an expert in pedagogical practices (Orlando, 2014). Other studies have also shown that barriers to implementing advanced technology applications in various educational settings were attributed to resistance from the older instructors (Huygelier et al., 2019; Seifert & Schlomann, 2021; Wu et al., 2015).

To counteract this phenomenon, scholars recommend providing pre-exposure to the immersive environment, allowing sufficient time to properly learn how to use the technology, and providing robust resources, such as additional instructors with expertise in VR technology, to guide them through troubleshooting and usage throughout their training and beyond (Huygelier et al., 2019; Seifert & Schlomann, 2021; Wu et al., 2015). It was also mentioned that immersive VR hesitancy could be counteracted if older adults would participate in the experience of wearing the headsets and immersing in the environment at least once. Indeed, one study reported that actual participation in immersive VR environment led to adaptability, motivation, and more positive perceptions of usage (Huygelier et al., 2019).

Within the participant's responses, as well as shown in prior studies, successful adoption of immersive VR technology is enhanced when sufficient time is given to train, use and troubleshoot a product's features; these attributes may increase "knowledge, self-efficacy and transfer" among instructors (Meyer et al., 2019, p.1). As such, careful consideration of generational differences in the educators involved in the training and implementation of the technology needs to be ascertained so that exposure to the device and a strategic training plan should be in place to give them time to learn the software, create and review the scenarios, and develop a sense of comfort with use.

One benefit that was suggested is that immersive VR may provide a safer environment to learn. As the learner is in an enclosed environment, learning is self-directed, even in the presence of the facilitator; this may support the concept of psychological safety, as learners are unable to see the instructor and progression of the scenario is exclusively learner driven (Riva, 2020; Willman et al., 2020). Furthermore, scholars report that learners see the benefit of immersive VR to support improvement of "clinical decision-making skills," as in the case of a patient deteriorating, and immersive VR may increase realism and cognitive objectivity (Aebersold et al., 2020; Saab et al., 2021, p. 5).

Use of immersive VR, specifically in context of matching the "fit" with the learner's needs, is vital to its success. The use of immersive VR maximizes time, decreases the need for additional resources, provides the learner with a sense of immersion and presence in the environment, provides unique learning opportunities, and aids in the ability for the learner to critically think (Liberatore & Wagner, 2021; Renganayagalu et al., 2021). The use of the software specifically designed for

management of the clinically deteriorating patient allows the newly licensed nurse to have more individualized opportunities to think critically and apply clinical reasoning skills. It is also important to note that adapting and implementing the program successfully needs to be properly thought out and designed in the context of the areas in which the learners work. Ideally, stakeholders would need to strategize and research selection of software and hardware, as well as to be involved in the development and integration of the technology to create learning that is "pedagogically sound" (Ferdig, 2006).

Participants discussed the need for having a dedicated space. In contrast to securing dedicated space in a hospital, studies have demonstrated the promising effects of providing immersive VR training remotely in higher education, within academic institutions for collaborative medical simulation learning, and within business (Nesenbergs et al., 2020). In fact, several disciplines have successfully participated in integrated remote training using immersive VR to teach concepts (Almousa et al., 2021; Nesenbergs et al., 2020; Jung & Dalton, 2021).

Although there is great promise in the advancement of immersive VR technologies to promote safer learning, immersive VR does come with some limitations. Several researchers reported that learners have experienced nausea, dizziness, disorientation, fatigue, and postural instability (Chen et al., 2020; Jensen & Konradsen, 2017; Kourtesis et al., 2019). Thus, immersive VR may not be appropriate for learners with severe motion sickness or several disorders that affect proprioception. To mitigate these circumstances, careful attention should be paid to the selection of the software, longevity of the states, and quality of the hardware to achieve the objectives and lessen

the symptomatology (Kourtesis et al., 2019). Hence, it is important for organizations to research the different options for immersive VR program that fit their organizational needs and have well developed guidelines before implementing training in their departments.

In summary, facilitators and barriers within this study linked to the conceptual model can be seen in Figure 2. Facilitators of integrating an immersive VR program for training newly licensed nurses include perceptions of the educators and the ability to receive adequate training on this technological pedagogy, as well as identifying and planning appropriate strategies to address barriers within the training perceptions based on age differences and the resources needed to provide training. Also, as seen in Figure 2, the aim of the study identified that there is a growing need for hospitals to develop innovative training platforms; major barriers to implementing the platforms evolve around time needed to train and integrate the product with all parties (inclusive of fear, safety and ability to facilitate the learning platform, despite the age groups perceived restrictions). As stated above, it is important to note that in order to overcome these barriers, a safe, strategically planned development and implementation of the platform is needed to address the appropriate amount of time to ensure immersive VR's success in any setting.

Limitations of the study included the inability for the participants to experience the actual use of the headsets and handheld manipulative devices due to the COVID-19 pandemic. However, the research team was able to interview participants over a large geographical population of diverse hospital organizations within the United States and Canada, which may lend to transferability of the study. In addition, further research

should explore the learner's perceptions of using immersive VR (in this case the newly licensed workforce group) to develop skills (Alfalah, 2018).

Conclusion

This study examined the perceptions of nursing educators, nursing education leaders and nurse simulation specialists with respect to identification of the potential value of using immersive VR in hospital programs to prepare newly licensed nurses for management of clinical deterioration. This need has been exacerbated due to the limited clinical experiences in pre licensure programs during the COVID pandemic. Future directions of this project include expanding the study to the impressions of clinical educators on the value of VR, exploring the perceptions of newly licensed nurses – particularly with respect to management of clinically deteriorating patients, and developing an algorithm of deteriorating scenarios (e.g., COVID pneumonia and septic shock) for psychometric testing within the immersive VR environment. Upon successful development of a reliable instrument, the second phase for research will include implementing the tool in in a group of newly licensed nurses in a joint study with several hospitals.

References

Abulfaraj, M. M., Jeffers, J. M., Tackett, S., & Chang, T. (2021). Virtual reality vs. high-fidelity mannequin-based simulation: A pilot randomized trial evaluating learner performance. *Cureus*. https://doi.org/10.7759/cureus.17091

Aebersold, M. (2016). The history of simulation and its impact on the future. *AACN Advanced Critical Care*, *27*(1), 56–61. https://doi.org/10.4037/aacnacc2016436

Aebersold, M., Rasmussen, J., & Mulrenin, T. (2020). Virtual everest: Immersive virtual reality can improve the simulation experience. *Clinical Simulation in Nursing*, *38*, 1–4. https://doi.org/10.1016/j.ecns.2019.09.004

Agency for Healthcare Research and Quality. (2019). *Failure to Rescue*. Retrieved March 12, 2021, from https://psnet.ahrq.gov/primer/failure-rescue

Alfalah, S., Falah, J., Alfalah, T., Elfalah, M., & Falah, O. (2017). Perceptions toward Adopting Virtual Reality as a Learning Aid in Information Technology. *International Journal of Computer and Information Engineering*, *11*(4), 463–467.

Alfalah, S. M. (2018). Perceptions toward adopting virtual reality as a teaching aid in information technology. *Education and Information Technologies*, *23*(6), 2633–2653. https://doi.org/10.1007/s10639-018-9734-2

Almousa, O., Zhang, R., Dimma, M., Yao, J., Allen, A., Chen, L., Heidari, P., & Qayumi, K. (2021). Virtual reality technology and remote digital application for tele-simulation and global medical education: An innovative hybrid system for clinical training. *Simulation & Gaming*, *52*(5), 614–634. https://doi.org/10.1177/10468781211008258

Al-Moteri, M., Plummer, V., Cooper, S., & Symmons, M. (2019). Clinical deterioration of ward patients in the presence of antecedents: A systematic review and narrative synthesis. *Australian Critical Care, 32*(5), 411–420. https://doi.org/10.1016/j.aucc.2018.06.004

Anton, N., Hornbeck, T., Modlin, S., Haque, M., Crites, M., & Yu, D. (2021). Identifying factors that nurses consider in the decision-making process related to patient care during the covid-19 pandemic. *PLOS ONE, 16*(7), e0254077. https://doi.org/10.1371/journal.pone.0254077

Badowski, D., Rossier, K. L., & Reiland, N. (2021). Exploring student perceptions of virtual simulation versus traditional clinical and manikin-based simulation. *Journal of Professional Nursing*, *37*(4), 683–689. https://doi.org/10.1016/j.profnurs.2021.05.005

Benner, P. (1984). From novice to expert excellence and power in clinical nursing practice. *AJN, American Journal of Nursing*, *84*(12), 1479. https://doi.org/10.1097/00000446-198412000-00025

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, *3*(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Brown, T., & Sorrell, J. (2017). Challenges of novice nurse educator's transition from practice to classroom. *Teaching and Learning in Nursing*, *12*(3), 207–211. https://doi.org/10.1016/j.teln.2017.03.002

Cant, R., Cooper, S., Sussex, R., & Bogossian, F. (2019). What's in a name? Clarifying the nomenclature of virtual simulation. *Clinical Simulation in Nursing*, *27*, 26–30. https://doi.org/10.1016/j.ecns.2018.11.003

Cant, R. P., & Cooper, S. J. (2009). Simulation-based learning in nurse education: Systematic review. *Journal of Advanced Nursing*, *66*(1), 3–15. https://doi.org/10.1111/j.1365-2648.2009.05240.x

Chen, F.-Q., Leng, Y.-F., Ge, J.-F., Wang, D.-W., Li, C., Chen, B., & Sun, Z.-L. (2020). Effectiveness of virtual reality in nursing education: Meta-analysis. *Journal of Medical Internet Research*, *22*(9), 1–12. https://doi.org/10.2196/18290

Coyne, L., Takemoto, J. K., Parmentier, B. L., Merritt, T., & Sharpton, R. A. (2018). Exploring virtual reality as a platform for distance team-based learning. *Currents in Pharmacy Teaching and Learning*, *10*(10), 1384–1390. https://doi.org/10.1016/j.cptl.2018.07.005

Crabtree, B., & Miller, W. (1999). *Doing qualitative research* (2nd Ed.). SAGE Publications, Inc. (US).

Davis, R. L. (2009). Exploring possibilities: Virtual reality in nursing research. *Research and Theory for Nursing Practice*, *23*(2), 133–147. https://doi.org/10.1891/1541-6577.23.2.133

Drenkard, K., Sallkalaris, B., Deyo, P., Abdillahi, S., & Hahn, H. (2021). University COVID -19 surveillance testing center: Challenges and opportunities for schools of nursing. *Journal of Professional Nursing*, *37*, 948–953. https://doi.org/10.1016/j.profnurs.2021.07.004

Farra, S., Smith, S., French, D., & Gillespie, G. (2015). Development of an assessment instrument to evaluate performance of the skill of decontamination. *Nurse Education Today*, *35*(10), 1016–1022. https://doi.org/10.1016/j.nedt.2015.04.010

Ferdig, R. E. (2006). Assessing technologies for teaching and learning: Understanding the importance of technological pedagogical content knowledge. *British Journal of Educational Technology*, *37*(5), 749–760. https://doi.org/10.1111/j.1467-8535.2006.00559.x

Fogg, N., Wilson, C., Trinka, M., Campbell, R., Thomson, A., Merritt, L., Tietze, M., & Prior, M. (2020). Transitioning from direct care to virtual clinical experiences during the covid-19 pandemic. *Journal of Professional Nursing*, *36*(6), 685–691. https://doi.org/10.1016/j.profnurs.2020.09.012

Foronda, C., Godsall, L., & Trybulski, J. (2013). Virtual clinical simulation: The state of the science. *Clinical Simulation in Nursing*, *9*(8), e279–e286. https://doi.org/10.1016/j.ecns.2012.05.005

Forsberg, E., Zeigert, K., Hult, H., & Fors, U. (2016). Assessing progression of clinical reasoning through virtual patients: An exploratory study. *Nurse Education in Practice, 16*, 97–103. https://doi.org/10.1016/j.nepr.2015.09.006

Grassini, S., Saghafian, M., Thorp, S., & Laumann, K. (2021). User individual characteristics and perceived usability in immersive hmd vr: A mixed method explorative study. In *Lecture notes in networks and systems* (pp. 157–165). Springer International Publishing. https://doi.org/10.1007/978-3-030-80091-8_19

Haerling, K. A. (2018). Cost-utility analysis of virtual and mannequin-based simulation. Simulation in Healthcare: The Journal of the Society for Simulation in Healthcare, 13(1), 33–40. https://doi.org/10.1097/sih.0000000000000280\

Huygelier, H., Schraepen, B., van Ee, R., Vanden Abeele, V., & Gillebert, C. R. (2019). Acceptance of immersive head-mounted virtual reality in older adults. *Scientific Reports*, *9*(1). https://doi.org/10.1038/s41598-019-41200-6

Jensen, L., & Konradsen, F. (2017). A review of the use of virtual reality head-mounted displays in education and training. *Education and Information Technologies*, *23*(4), 1515–1529. https://doi.org/10.1007/s10639-017-9676-0

Jones, D., Mitchell, I., Hillman, K., & Story, D. (2013). Defining clinical deterioration. *Resuscitation*, *84*(8), 1029–1034. https://doi.org/10.1016/j.resuscitation.2013.01.013

Jung, T., & Dalton, J. (Eds.). (2021). *Xr case studies*. Springer International Publishing. https://doi.org/10.1007/978-3-030-72781-9

Kourtesis, P., Collina, S., Doumas, L. A., & MacPherson, S. E. (2019). Validation of the virtual reality neuroscience questionnaire: Maximum duration of immersive virtual reality sessions without the presence of pertinent adverse symptomatology. *Frontiers in Human Neuroscience*, *13*. https://doi.org/10.3389/fnhum.2019.00417

Liaw, S., Scherpbier, A., Klainin-Yobas, P., & Rethans, J.-J. (2011). Rescuing a patient in deteriorating situations (rapids): An evaluation tool for assessing simulation performance on clinical deterioration. *Resuscitation*, *82*(11), 1434–1439. https://doi.org/10.1016/j.resuscitation.2011.06.008

Liberatore, M. J., & Wagner, W. P. (2021). Virtual, mixed, and augmented reality: A systematic review for immersive systems research. *Virtual Reality*, *25*(3), 773–799. https://doi.org/10.1007/s10055-020-00492-0

Loprieto, J. O. (2013). *Healthcare Simulation Dictionary*. Agency for Healthcare and Research Quality. Retrieved February 5, 2021, from https://www.ahrq.gov/sites/default/files/publications/files/sim-dictionary.pdf

Madden, J., Pandita, S., Schuldt, J. P., Kim, B., S. Won, A., & Holmes, N. G. (2020). Ready student one: Exploring the predictors of student learning in virtual reality. *PLOS ONE*, *15*(3), 1–26. https://doi.org/10.1371/journal.pone.0229788

Makransky, G., & Petersen, G. B. (2021). The cognitive affective model of immersive learning (camil): A theoretical research-based model of learning in immersive virtual reality. *Educational Psychology Review*, *33*(3), 937–958. https://doi.org/10.1007/s10648-020-09586-2

Manakatt, B. M., Carson, Z. W., Penton, R. L., & Demello, A. S. (2021). Virtual learning experiences in population health nursing course during the covid-19 pandemic. *International Nursing Review*, *68*(4), 557–562. https://doi.org/10.1111/inr.12725

Massey, D., Chaboyer, W., & Anderson, V. (2016). What factors influence ward nurses' recognition of and response to patient deterioration? An integrative review of the literature. *Nursing Open*, *4*(1), 6–23. https://doi.org/10.1002/nop2.53

McGrath, J. L., Taekman, J. M., Dev, P., Danforth, D. R., Mohan, D., Kman, N., Crichlow, A., & Bond, W. F. (2017). Using virtual reality simulation environments to assess competence for emergency medicine learners. *Academic Emergency Medicine*, *25*(2), 186–195. https://doi.org/10.1111/acem.13308

Meyer, O. A., Omdahl, M. K., & Makransky, G. (2019). Investigating the effect of pre-training when learning through immersive virtual reality and video: A media and methods experiment. *Computers & Education, 140*, 103603. https://doi.org/10.1016/j.compedu.2019.103603

Naciri, A., Radid, M., Kharbach, A., & Chemsi, G. (2021). E-learning in health professions education during the covid-19 pandemic: A systematic review. *Journal of Educational Evaluation for Health Professions, 18*, 27. https://doi.org/10.3352/jeehp.2021.18.27

NCBSN. (2021). *NCBSN Guiding Principles*. National Council for State Boards of Nursing. Retrieved March 13, 2021, from https://www.ncsbn.org/1325.htm

Nesenbergs, K., Abolins, V., Ormanis, J., & Mednis, A. (2020). Use of augmented and virtual reality in remote higher education: A systematic umbrella review. *Education Sciences*, *11*(1), 8. https://doi.org/10.3390/educsci11010008

Nordick, C. L. (2020). Integrating strategies for improving diagnostic reasoning and error reduction. *Journal of the American Association of Nurse Practitioners*, *33*(5), 366–372. https://doi.org/10.1097/jxx.0000000000000464

Padilha, J., Machado, P., Ribeiro, A., Ramos, J., & Costa, P. (2019). Clinical virtual simulation in nursing education: Randomized controlled trial. *Journal of Medical Internet Research*, *21*(3), 1–9. https://doi.org/10.2196/11529

Padilla, R. M., & Mayo, A. (2018). Clinical deterioration: A concept analysis. *Journal of Clinical Nursing*, *27*(7-8), 1360–1368. https://doi.org/10.1111/jocn.14238

Petersen, G., Petkakis, G., & Makransky, G. (2022). A study of how immersion and interactivity drive vr learning. Computers & Education, 179, 104429.

https://doi.org/10.1016/j.compedu.2021.104429Prion, S., & Haerling, K. (2020). Evaluation of simulation outcomes. *Annual Review of Nursing Research, 39*(1), 149–180. https://doi.org/10.1891/0739-6686.39.149

Radianti, J., Majchrzak, T. A., Fromm, J., & Wohlgenannt, I. (2020). A systematic review of immersive virtual reality applications for higher education: Design elements, lessons learned, and research agenda. *Computers & Education*, *147*, 103778. https://doi.org/10.1016/j.compedu.2019.103778

Renganayagalu, S., Mallam, S. C., & Nazir, S. (2021). Effectiveness of vr head mounted displays in professional training: A systematic review. *Technology, Knowledge and Learning*, *26*(4), 999–1041. https://doi.org/10.1007/s10758-020-09489-9

Riva, G. (2020). Virtual reality in clinical psychology. In *Reference module in neuroscience and biobehavioral psychology*. Elsevier. https://doi.org/10.1016/b978-0-12-818697-8.00006-6

Rupley, D., Grilo, S. A., Kondragunta, S., Amiel, J., Matseoane-Peterssen, D., Catallozzi, M., & Westhoff, C. L. (2020). Mobilization of health professions students during the covid-19 pandemic. *Seminars in Perinatology*, *44*(7), 151276. https://doi.org/10.1016/j.semperi.2020.151276

Saab, M. M., Hegarty, J., Murphy, D., & Landers, M. (2021). Incorporating virtual reality in nurse education: A qualitative study of nursing students' perspectives. *Nurse Education Today, 105*, 105045. https://doi.org/10.1016/j.nedt.2021.105045

Saghafian, M., Laumann, K., & Skogstad, M. (2021). Organizational challenges of development and implementation of virtual reality solution for industrial

operation. *Frontiers in Psychology*, *12*. https://doi.org/10.3389/fpsyg.2021.704723

Saldana, J. (2021). *The coding manual for qualitative researchers* (4th Ed.). SAGE Publications Ltd.

Samadbeik, M., Yaghoobi, D., Bastani, P., Abhari, S., Rezaee, R., & Garavand, A. (2018). The Applications of Virtual Reality Technology in Medical Groups Teaching. *Journal of Advances in Medical Education & Professionalism*, *6*(3), 123–129.

Sánchez, Á., María Barreiro, J., & Maojo, V. (2000). Design of Virtual Reality Systems for Education: A Cognitive Approach. *Education and Information Technologies*, *5*(4), 345–362. https://doi.org/10.1023/a:1012061809603

Sankey, C. B., McAvay, G., Siner, J. M., Barsky, C. L., & Chaudhry, S. I. (2016). "Deterioration to door time": An exploratory analysis of delays in escalation of care for hospitalized patients. *Journal of General Internal Medicine*, *31*(8), 895–900. https://doi.org/10.1007/s11606-016-3654-x

Saunier, J., Barange, M., Blandin, B., & Querrec, R. (2016). A methodology for the design of pedagogically adaptable learning environments. *International Journal of Virtual Reality*, *16*(1), 15–21. https://doi.org/10.20870/ijvr.2016.16.1.2878

Seifert, A., & Schlomann, A. (2021). The use of virtual and augmented reality by older adults: Potentials and challenges. *Frontiers in Virtual Reality*, *2*. https://doi.org/10.3389/frvir.2021.639718

Simmons, B., Lanuza, D., Fonteyn, M., Hicks, F., & Holm, K. (2003). Clinical reasoning in experienced nurses. *Western Journal of Nursing Research*, *25*(6), 701–719. https://doi.org/10.1177/0193945903253092

Sitterding, M. C., Raab, D. L., Saupe, J. L., & Israel, K. J. (2019). Using artificial intelligence and gaming to improve new nurse transition. *Nurse Leader*, *17*(2), 125–130. https://doi.org/10.1016/j.mnl.2018.12.013

Vincent, J.-L., Einav, S., Pearse, R., Jaber, S., Kranke, P., Overdyk, F. J., Whitaker, D. K., Gordo, F., Dahan, A., & Hoeft, A. (2018). Improving detection of patient deterioration in the general hospital ward environment. *European Journal of Anaesthesiology*, *35*(5), 325–333. https://doi.org/10.1097/eja.0000000000000798

Wang, R., DeMaria, S., Goldberg, A., & Katz, D. (2016). A systematic review of serious games in training health care professionals. *Simulation in Healthcare: The Journal of the Society for Simulation in Healthcare*, *11*(1), 41–51. https://doi.org/10.1097/sih.0000000000000118

Weiß, S., Bongartz, H., Boll, S., & Heuten, W. (2018). Applications of Immersive VR in Nursing Education. *Zukunft der Pflege - Innovative Technologien für die Pflege*.

White, A., Maguire, M. R., Brannan, J., & Brown, A. (2021). Situational awareness in acute patient deterioration. *Nurse Educator*, *46*(2), 82–86.

Willman, A., Bjuresäter, K., & Nilsson, J. (2020). Newly graduated registered nurses' self-assessed clinical competence and their need for further training. *Nursing Open*, *7*(3), 720–730. https://doi.org/10.1002/nop2.443

Wu, Y.-H., Ware, C., Damnée, S., Kerhervé, H., & Rigaud, A.-S. (2015). Bridging the digital divide in older adults: A study from an initiative to inform older adults

about new technologies. *Clinical Interventions in Aging*, 193. https://doi.org/10.2147/cia.s72399

Zhang, J., & Walji, M. F. (2011). TURF: Toward a unified framework of EHR usability. *Journal of Biomedical Informatics*, *44*(6), 1056–1067. https://doi.org/10.1016/j.jbi.2011.08.005

Appendix B

Table 1

Participants Sociodemographic Characteristics (n=20)

Characteristic	N (%)
Role	
Nurse Leader (L1-L5)	5 (25%)
Nurse Educator (E1-E7)	7 (35%)
Nurse Simulation Specialist (SS1-SS3)	3 (15%)
Group Interview (Nurse Educators) (G1-G5)	5 (25%)
Gender	
Male	1 (5%)
Female	19 (95%)
Race	
White/Caucasian	11 (55%)
Black/African American	7 (35%)
Hispanic/Latino	2 (10%)
Age Group	
31-35	2 (10%)
36-40	3 (15%)
41-45	4 (20%)
46-50	4 (20%)
51-55	1 (5%)
56-60	5 (25%)
61-65	1 (5%)
Hospital Setting Participant Works In	
Non-profit teaching hospital > 500 beds	8 (40%)
Non-profit teaching hospital < 500 beds	4 (20%)
Teaching Hospital < 500 beds	6 (30%)
Non-profit safety net teaching hospital	1 (5%)
Community Hospital	1 (5%)
Highest Level of Education Completed	
Baccalaureate Degree in Nursing	1 (5%)
Master's Degree in Nursing	14 (70%)
Master's Degree Other Than Nursing	2 (10%)
Doctorate in Nursing	3 (15%)
Employment Status	
Full-Time	19 (95%)
Part-Time	1 (5%)
Years of experience as a nurse	
5 years or less	5 (25%)
> than 5 Years	15 (75%)

Years of experience in education	
2 years	5 (25%)
3-5 years	7 (35%)
> than 5 Years	8 (40%)
Experience with Use of Simulation	
1 year	2 (10%)
2 years	6 (30%)
3- 5 years	6 (30%)
> 5 years	6 (30%)

Table 2

Population Comparison by Groups

	Leaders (L)	Educators (E)	Simulation Specialists (SS)	Group Interview Participants (GI)
Number of Participants	5	7	3	5
Level of Education	4 Master's prepared 1 Doctoral prepared	6 Master's prepared 1 Doctoral prepared	2 Master's prepared 1 Baccalaureate prepared	5 Master's prepared
Years of Experience in Nursing (M)	22.2	26.9	16.7	25
Gender	Female	6 Female 1 Male	Female	Female
Hospital Size	< 500 Beds > 500 beds Rural Hospital	Safety Net Hospital < 500 beds > 500 beds	2 <500 beds 1 > 500 beds	> 500 beds
Experience in Simulation	> 5 years	4= > 5 years 3= < 5 years	3-5 years	4 = < 5 years 1 = > 5 years

Table 3

Themes, subthemes, and codes correlated to facilitators and barriers

Themes	Subthemes	Relation to Model	Facilitators	Barriers	Codes linked to associated themes
Clinical reasoning skills of the newly licensed nurse	Clinical Deterioration User Cases for Clinical Reasoning Skills	User perceptions: Value of pedagogy Value of technology related to gap of clinical reasoning skills Development of scenarios to mature clinical reasoning skills Source knowledge Materials	“lacking” “Missing” “a gap” “don’t know how to switch their brains” “limited” “not very much” “disconnected”	N/A	Opportunityforgrowth IsMissing GNPriorExperience Gap LackingClinReasoning Limited Lacking They don't have very much Ambiguity Disconnected Materials User Case Critical thinking Complement Experience Scenario Critical Thinking Application MentalHealthD/O Presence Immersion Individualized plan Realism Connectingthedots Repetition Learningmuscle
Perceptions of adaptability of Immersive VR	Perceptual bias of generations	User perceptions: Students will like	“fun” “exciting” “We should be using this “pedagogy”	N/A	Limited Fun Exciting BookKnowledge Lacking

	Technology Adaptability and Motivation Resistance to Change Efficiency	Educators will like but could have trouble adapting User perception Environment Materials Materials /Environment	"lot of value to it"		Edu-excited Age Seasoned nurses Stressors Pushback Generational _Differences Senior Members Generations Resistant Younger-generation Open-mindedness Cool Adaptability Vulnerable Exciting Motivation UnderstandingofVR Adaptable Edu_Adaptible Tired
Psychological Safety	Fear and vulnerability Providing a Safe Space to Identify Knowledge Deficiencies	User perceptions: Educators may be uncomfortable Students may appreciate the safety of learning	Creating a safe space for the learner to learn Creating a safe space for the user to receive training without embarrassment	Fear of using the technology Gaps in technology usage Gaps in identifying clinical deterioration in a scenario Fear of educator loss	Fear Vulnerability Safety Gapinlearning

				of position of power as an expert when changing pedagogies	
Organizational support and resources	Stakeholders Environmental Context Space/Cost Internet and Software Infrastructure Dedicated training time for educators and end users	Materials Environment User perceptions Value of technology	Stakeholders involved need to be included in decision making Appropriate bandwidth should exist for use of internet to run software Need to ensure dedicated time to learn technology	Decreased space available Too many projects and duties that decrease learning time of pedagogy	CurrentSpace Space Financial ITInfrastructure Stakeholders LeaderBuyin Timetotrain Learning Gapinlearning Resources:ClinicalExperts DesignScenario Cost Budget Resources Training Dedicatedtime Barrier:Space MulipleSpaces FocusedTraining LearnerPrepTime DedicatedTraining

Figure 1

Educational VR system model. Reprinted through permission of the author (Alfalah, 2018)

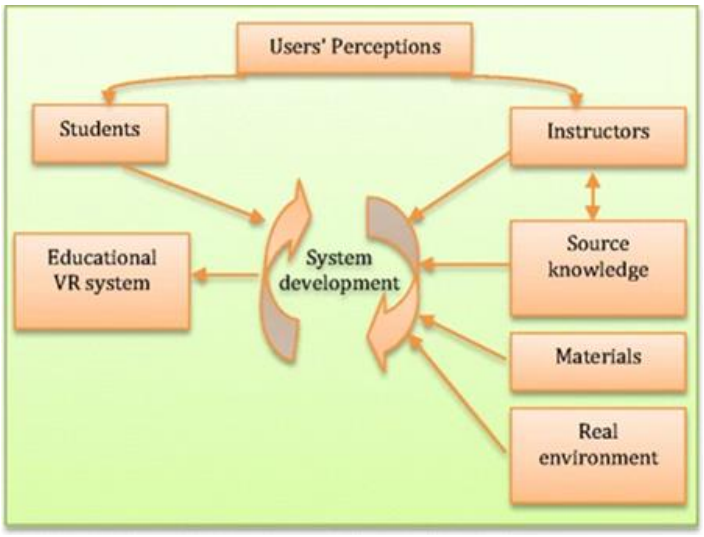
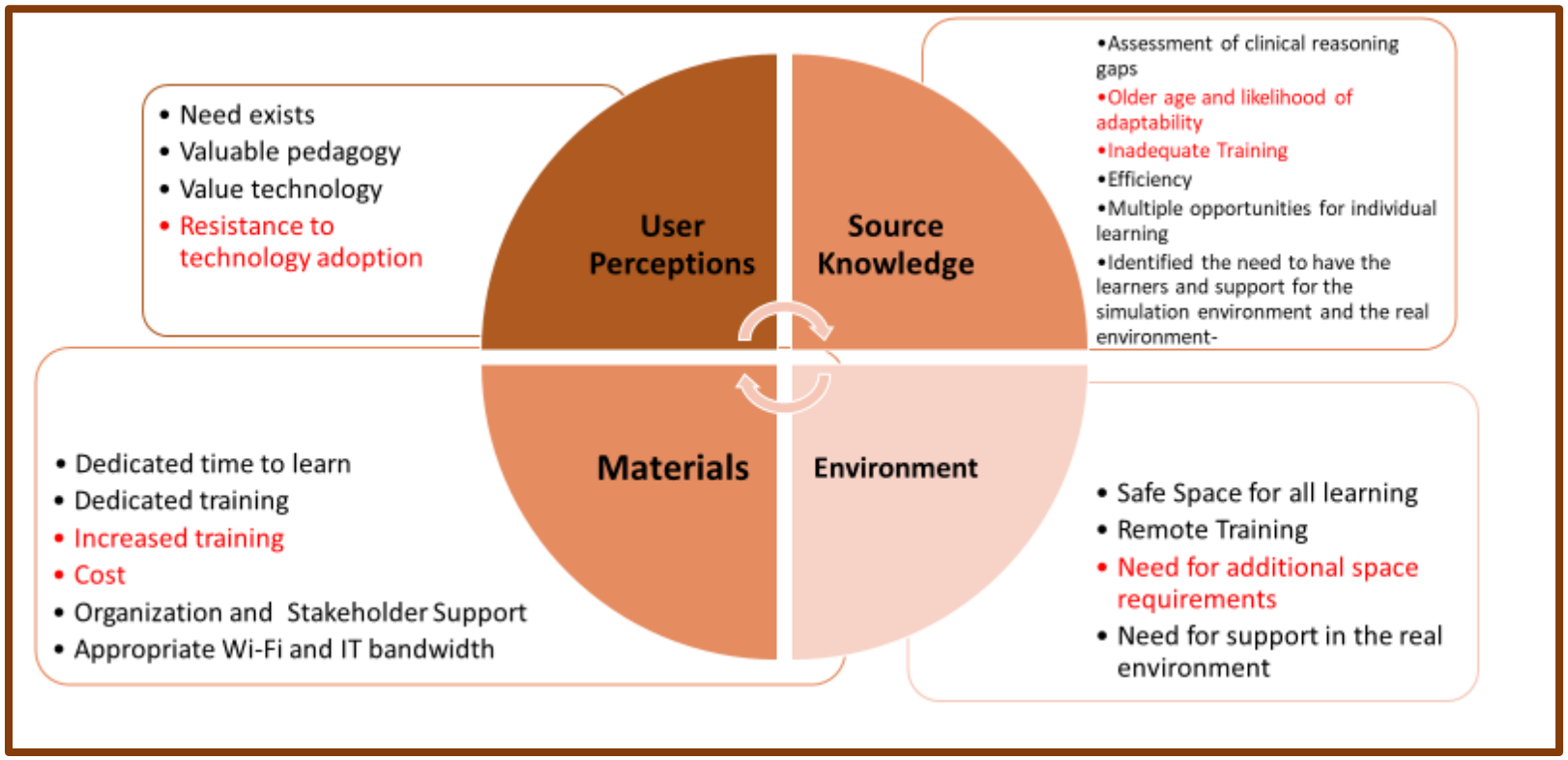


Figure 2

Facilitators and barriers linkage to the conceptual model (Barriers of the participant's responses are indicated in red)



CURRICULUM VITAE

Ladonna Y. Christy PHD(C), RN, NEA-BC, CCRN-K, NPD-BC, CHSE

ladonna.y.christy@uth.tmc.edu

EDUCATION

Degree	*Institution*	*Date*
	University of Texas Health Science Center Cizik School of Nursing	
Doctor of Philosophy		2022
	Walden University	
Masters in Nursing Education		2013
Bachelors of Science in Nursing		2011
	El Paso Community College	
Associates of Applied Science in Nursing		2005
Licensed Vocational Nurse		2003

LICENSURE & CERTIFICATION

State	*Active or Inactive*
NEA-BC Nurse Executive Advanced Certification	Active
ANCC Nursing Professional Development Certification	Active
CCRN Certification	Active
Certified Healthcare Simulation Educator Certification	Active

PROFESSIONAL EXPERIENCES

Institution	*Position Title*	*Inclusive Dates*
Western Governor's University	Clinical Lab Instructor, Simulation Specialist	January 2018-Present
University of St Thomas	Adjunct Instructor	July 2013-Present
Tuba City Regional Healthcare Corporation	Madison Miles, Interim Executive Director of Staff Development	November 2021-February 2021
Houston Methodist Hospital	Virtual ICU Clinician	October 2020-February 2021
Aya Healthcare	Travel Nurse	August-October 2020
CommonSpirit Health Baylor St. Luke's Hospital, Texas Medical Center	Interim, Director of Nursing and Patient Education	September 2020-November 2021
CommonSpirit Health Baylor St. Luke's Hospital, Texas Medical Center	Director, Clinical Education	November 2019-November 2021
Houston Methodist Hospital, Texas Medical Center	Nurse Program Leader, Critical Care Education and Simulation Program	June 2015-November 2019
Chamberlain University	Visiting Professor, Adjunct Instructor	October 2014-April 2017

Harris Health System Lyndon B Johnson Hospital	Clinical Resource Nurse	June 2013- June 2015
Harris Health System Lyndon B Johnson Hospital	Nursing Clinical Manager	2011- 2013
Memorial Hermann Health System, Texas Medical Center, Woodlands, and Southwest Campuses	Charge nurse, staff nurse, Cardiovascular Intensive Care Unit, Surgical Intensive Care Unit, Medical Surgical Intensive Care Unit, IMU/Stepdown	June 2008- December 2011
Veterans' Health Affairs	RN Special Needs Chronically Mentally Ill Nurse Clinician	January 2007- September 2007
Crdentia, Medical Staffers Inc. Network	Travel Nurse/Per Diem Nurse	August 2003- January 2008

HONORS AND AWARDS

Award	*Awarding organization*	*Date*
Scholarship Recipient	AACN (American Association of Critical Care Nurses)	2021
Bronze Recipient	Good Samaritan Award	2021
Scholarship recipient	ANPD (Association for Nursing Professional Development)	2021
Bronze Recipient	Good Samaritan Award	2018
Houston Top 150 Nurses Award		2018
Circle of Excellence Nomination	AACN (American Association of Critical Care Nurses)	2016
Nurses Week Nursing Excellence Runner- Up		2015
Silver Recipient	Good Samaritan Award	2015

Winner	Performance Improvement Project: Vancomycin Trough	2013
Harris Health Innovation Participant Runner Up	Harris Health	2012
Harris Health Leadership/Advancement Honors	Harris Health	2011
Quality Award Participation Runner Up		2011

PUBLICATIONS

Christy, L.Y, McEwen, M., Ottosen, M. Franklin, A. Perceptions of Integrating Immersive Virtual Reality Simulation as a Teaching Methodology. (In review, pending acceptance of manuscript).
Clinical Simulation in Nursing Journal. Spring 2022.

Christy, L., and Beth Cook. Critical Care Fellowship Program: Implementing innovative educational programs in the hospital setting for critical care needs. (In progress- to submit to American Association of Critical Care Nurses 2022 March).

Rouse, M., & Christy, L. (2021). Meeting the environmental and staffing demands of the covid-19 pandemic. Journal for Nurses in Professional Development, Publish Ahead of Print. https://doi.org/10.1097/nnd.0000000000000839

Christy, L., & Senneff, J. (2019). Progressive care nurse residency program. Journal of Nursing, Education and Practice, 9(12), 19–26. https://doi.org/10.5430/jnep.v9n12p19

Hamlin, S. K., Strauss, P. Z., Chen, H.-M., & Christy, L. (2017). Microvascular fluid resuscitation in circulatory shock. Nursing Clinics of North America, 52(2), 291–300. https://doi.org/10.1016/j.cnur.2017.01.006

Preventing Falls in a Progressive Care Setting, Evidenced Based Project completed March 2016, Houston Methodist Hospital

Increasing Mobility in the Cardiothoracic Postoperative Patient, Evidenced Based Project, completed January 2016, Houston Methodist Hospital

PRESENTATIONS

"Using high fidelity to simulate a COVID-19 patient tracheostomy: Lessons learned"
Laerdal Webinar
(Virtual Conference)
August and October 2020

Clinical Utility of Early Warning Scores: A Systematic Review
ANIA Conference 2020, Chicago, Illinois
(Virtual Conference)
August 2020

Wellness Presentation. AACN Critical Care Symposium.
Webinar Conference
April 2019

Building an Inpatient Simulation Lab. Simulation User Network (SUN) Conference
Houston Community College, Texas Medical Center, Houston, Texas
September 2019

DNP versus PhD: Choosing the right degree for the future of education. Texas Children's Hospital Education Conference, Houston, Texas
September 2019

Implementing Best Practices to decrease central line infections in the adult inpatient setting.
Texas Children's Hospital Evidenced Based Practice Forum, Houston, Texas
August 2019

Using E-Learning Technology to Implement CPOT Education to a 6-Hospital Teaching System. Sigma Theta Tau's 30th International Nursing Research Congress, Calgary, Alberta, Canada
July 2019

Progressive Care: Creating an Educational Program to Improve Care in a Specialized Population: Presentation.
Society of Critical Care Medicine Conference, San Diego, California
February 2019

Progressive Care Residency Programs: Bridging the education gap between critical and progressive care units: Oral Presentation.
2018 International Evidenced Based Conference, Osaka, Japan
August 2018

Suicide: Examining the tenth leading cause of death: DNP Symposium University of Texas Health Science Center
Houston, Texas
April 2017

"Workplace Wellness" a 1 contact hour webinar for The American Nurses Association
January 2017

"Increasing Mobility in the Cardiothoracic Postoperative Patient" Evidenced Based Symposium
Houston Methodist Hospital, Houston, Texas
April 2016

"Preventing Falls in a Progressive Care Setting" EBP presented to ANCC Magnet Team, Houston Methodist Hospital, Houston, Texas
October 2016

What's the skinny on PICO? Collaborative Educator presentation at University of St Thomas School of Nursing Forum
February 2015

Pressure Ulcer Prevention" Presented at the Summer Institute, San Antonio Texas
August 2012

Harris Health System Podium Presentation- To Turn or Not to Turn: Nurse's Perceptions of Pressure Ulcer Prevention in the critically ill
December 2012

"Zap the VAP" Research Project for Harris Health System, presented at NAPH Summer Institute, San Antonio Texas
July 2011

PROFESSIONAL MEMBERSHIPS

American Association of Critical Care Nurses
Society for Simulation in Healthcare
Association for Nursing Professional Development
Sigma Theta Tau