CAREGIVR: BUILDING SELF-EFFICACY IN DEMENTIA CARE THROUGH IMMERSIVE EDUCATION

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ABSTRACT

Background: Over the next three decades, the number of older persons is projected to more than double worldwide, reaching more than 1.5 billion in 2050 (World Health Organization, 2019). Globally, the number of adults with dementia could rise from about 57.4 million in 2019 to 152.8 million by 2050 (World Health Organization, 2019). This reflects an increase of 166%. Current dementia education for practical nursing students is mostly reliant on traditional teaching methods including lecture-based courses and clinical placements, with limited opportunity to develop competence through repetition. One example of an emerging technology in nursing education is virtual reality (VR). Virtual reality can provide a level of immersion into a virtual environment, thereby mimicking reality, and providing opportunity for immediate performance feedback and repetition as necessary, providing ongoing, iterative learning.

Increased self-efficacy, the belief in our ability to meet challenges, has been linked to the reduction of stress (Tang & Chan, 2016). Within the nursing student population self-efficacy has been correlated with higher resiliency, leading to improved academic performance and ability to carry out the role of the nurse in the clinical setting (Cuartero & Tur, 2021). While a variety of educational strategies exist to attempt to accomplish improving self-efficacy for nursing students, no studies have been conducted on the use of immersive virtual reality as a potential tool for improving self-efficacy in nursing students for managing aggressive behaviors in clients with dementia.

Methodology: In this project an explanatory sequential mixed-methods design with an interpretive descriptive approach was used to compare perceived self-efficacy for practical nursing students who used the CareGiVR™ virtual reality application with those who did not. The following research questions were addressed:

(1) Does perceived self-efficacy improve for practical nursing students who use the CareGiVR™

application compared to those who do not, in relation to managing aggressive behaviors in clients with dementia?

(2) Are there significant differences between practical nursing students' perceived self-efficacy with managing aggressive behaviors in clients with dementia before and after using the CareGiVR™ application?

(3) How did practical nursing students perceive using the CareGiVR™ application influenced their self-efficacy with managing aggressive behaviours in clients with dementia?

Participants were recruited through email invitation and classroom presentations. The Inventory of Geriatric Nursing Self-Efficacy (IGNSE) measured changes in perceived self-efficacy pre and post-intervention, followed by qualitative focus groups.

Results: Forty-six students total (49%) responded to the invitation to participate in the quantitative component. Fifteen students from the intervention group, who utilized the CareGiVR™ application, elected to participate in the follow-up qualitative focus groups.

Findings indicate participants who used the CareGiVR™ application reported statistically significant higher levels of perceived self-efficacy post-intervention, compared with their baseline. Compared to the control group, participants who used the CareGiVR™ application had statistically significant higher levels of perceived self-efficacy following their clinical rotation. Four themes were identified during the qualitative analysis: getting real-world experience, a safe place to practice, meeting the client where they are at, and a tool, not a replacement.

Conclusion: These findings support the use of immersive virtual reality as an effective tool to increase perceived self-efficacy for managing aggressive behaviors in clients with dementia for practical nursing students.

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DEDICATION

To all of the frontline healthcare workers, who work tirelessly to provide kind, compassionate, care to our loved ones.

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LIST OF ABBREVIATIONS

ID – Interpretive description

IGNSE - Inventory of Geriatric Nursing Self-Efficacy

VR – Virtual reality

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CHAPTER 1

Over the next three decades, the number of older persons is projected to more than double worldwide, reaching more than 1.5 billion in 2050 (World Health Organization, 2019). Globally, the number of adults with dementia is predicted to rise from about 57.4 million in 2019 to 152.8 million by 2050, driven by factors like midlife obesity, smoking and social isolation (GBD 2019 Dementia Forecasting Collaborators, 2022). This change reflects a projected increase of 166% of adults worldwide with dementia. To meet the rapidly growing need for dementia care the future nursing workforce will need the requisite knowledge, skills, and attitudes. Nursing programs must increase effective and evidence-based interventions to continue to improve nursing student competencies to care for people with dementia (Cariñanos-Ayala, 2022). Virtual reality is a form of virtual simulation characterized as a 3-dimensional world, which is interactive through touch and motion (Lioce et al., 2020). Virtual reality (VR) has been suggested as a tool to supplement conventional teaching methods in nursing education (Woon, 2021). With the increasing use of VR within nursing education, the student perception of the technology needs to be examined.

1. 0 Purpose of the Study

The purpose of this study was to explore the following research questions:

(1) Does perceived self-efficacy improve for practical nursing students who use the CareGiVR^{TM} application compared to those who do not, in relation to managing aggressive behaviors in clients with dementia?

(2) Are there significant differences between practical nursing students' perceived self-efficacy with managing aggressive behaviors in clients with dementia before and after using the CareGiVR^{TM} application?

(3) How did practical nursing students perceive using the CareGiVR^{TM} application

influenced their self-efficacy with managing aggressive behaviours in clients with dementia?

1.0.1 Hypothesis

The following hypotheses were tested in the quantitative component of this study:

(1) There is a significant difference in perceived self-efficacy between practical nursing students who used the CareGiVR™ application, compared to those who did not, with managing aggressive behaviors in clients with dementia.

(2) There is a significant difference in perceived self-efficacy for practical nursing students' before and after using the CareGiVR™ application with managing aggressive behaviors in clients with dementia.

1.1 Background

Nursing education programs seek to integrate theory and practice to help students develop the requisite knowledge, skills, and attitudes to enter the nursing profession. The importance of preparing nursing students to care for clients with dementia has been well recognized as a necessary part of the nursing curriculum (Alushi et al., 2015; Cariñanos-Ayala, 202). However, Eccleston et al. (2015) identified nursing students lack knowledge around progression, symptoms, and management of dementia. This lack of knowledge suggests that as students graduate, they may not have the necessary preparation to care for the increasing number of people with dementia (Eccleston et al., 2015). Long and Hale (2022) found that nursing students often take a more conservative approach to managing aggressive behaviours and are more likely to ask for help or wait to intervene, possibly due to low self-confidence or lack of knowledge. By nature of the clinical setting nurses are often required to make decisions quickly to support positive outcomes for clients. In recent research, students expressed concern about the

management of unpredictable behaviours and negative feelings of fear and exhaustion when caring for this population (Kimzey et al., 2019). In their study, Kimzey et al. (2019) discuss how experiential learning in a simulated environment prior to entering the clinical setting may improve knowledge and attitudes of students providing dementia care to older adults.

To protect patient safety, students will often practice skills and assessments in nursing laboratories before entering the clinical setting to care for an actual client. Within the laboratory, simulations can mimic the actual practice setting while providing a safe environment to make errors. Typically these simulations have included mannequins, role-playing, standardized-patients, and virtual environments, including immersive virtual reality (Kim et al., 2016). The simulations can range from low-fidelity to high-fidelity depending on the specified learning objective for the student (Kim et al., 2016).

Virtual reality is emerging as a type of high-fidelity simulation within nursing education. Because this technology has only recently been applied to the nursing context, there is a paucity of research conducted in this area. Current literature has explored how virtual reality is being utilized in nursing education in a variety of settings, including for the purposes of knowledge building and skill acquisition (Chen et al., 2020). Within the older adult population studies are few, however, researchers have explored the use of virtual reality for enrichment (Chaze et al., 2021; Riaz et al., 2021) and physical functioning (Corregidor-Sánchez et al., 2020; Molina et al., 2021). Most studies have looked at older adults as the focus population, rather than the nurses and nursing students who provide the care.

Several studies were previously conducted using virtual reality as an intervention for improving knowledge of dementia care (Adefila et al., 2016; Jütten et al., 2017; Kidd et al., 2012; Kimzey et al., 2019; O'Connor et al., 2014; Wijma et al., 2017). The populations within

these studies included: health professions students (Adefila et al., 2016), mental health nursing students (Kidd et al., 2012), undergraduate nursing students (Kimzey et al., 2019), and non-professional caregivers of loved ones with dementia (Jütten et al., 2017; O'Connor et al., 2014). None of these studies included practical nursing students as the focus population. The definition of VR varied significantly in terms of immersion level from study to study, and included computer-based programs (O'Connor et al., 2014; Kidd et al., 2012;), simulated home environments (Jütten et al., 2017), non-interactive 360º videos (Wijman et al., 2017) and 360º wall-based projections (Stargatt et al., 2021). Most studies measured the feasibility and potential of using the VR training as a teaching intervention (Jütten et al., 2017; Kidd et al., 2012; O'Connor et al., 2014; Wijma et al., 2017). One study measured empathy and caregiver's perceived sense of confidence (Adefila, et al., 2016). The study found both had significantly improved following the VR intervention (Adefila, et al., 2016). Stargett et al. (2021) assessed whether the VR simulation would help formal caregivers identify physical aspects of a room which could be modified to assist clients with dementia. The post-test results indicated improved knowledge (Stargett et al.). At the time of the literature review, no studies with a controlled design and group comparisons were found using virtual reality for dementia care education. Therefore, there remains a lack of understanding as to how immersive virtual reality can influence student perceptions of self-efficacy in managing aggressive behaviours in clients with dementia.

Previous studies using VR with students in a variety of settings identified the value of the technology for improving knowledge gain (Adhikari et al., 2021; Saab et al., 2022; Samosorn et al., 2020), promoting engagement (Adhikari et al., 2021; Botha et al., 2021 Butt et al., 2018; Chao et al., 2021; Lange et al., 2020; Saab et al., 2022), skill acquisition (Chang & Lai, 2021;

Kardong-Edgren et al., 2019), building self-confidence (Adhikari et al., 2021; Chao et al., 2018; Farra et al., 2018) and perspective taking (Ma et al., 2021 & Saab et al., 2022). Recent studies have explored student perceptions on how they felt the technology could contribute to their overall learning (Farra et al., 2018; Thompson et al., 2020). None of the mentioned studies specifically addressed self-efficacy in a practical nursing student population. Practical nursing students are diploma prepared nursing professionals with a variety of skills and scope of practice (College of Licensed Practical Nurses of Alberta, 2022).

Several key terms are used to convey concepts that were fundamental to this study: virtual reality, dementia, self-efficacy, and the CareGiVR™ application. In the following section, each key concept is defined in terms of the context of this study. These definitions promote shared understanding of these terms.

1.1.1 Virtual Reality

Historically, VR has been used in the entertainment, tourism, and retail industries. However, VR has recently garnered increased attention for its use in health education programs versus being solely for entertainment and gaming (Fealy et al., 2019; Jiang et al., 2022; Rizzetto et al., 2020). VR has the potential to improve skill acquisition for heath care providers (Butt et al., 2018; Chang & Lai, 2021; Chu-Ling, 2022; Jenson & Forsyth, 2012; Kardong-Edgren et al., 2019). Several studies have evaluated the use of VR for knowledge acquisition in nursing (Adhikari et al., 2021; Askoy, 2019; Chao et al., 2021; Saab et al., 2022; Samosorn et al., 2020). Health education program expect students will demonstrate a minimum level of knowledge and skills competence before entering the clinical environment. Programs also teach the emotional skills necessary to deliver effective care. These skills include empathy, self-efficacy, and the ability to foster positive relationships. VR has also been leveraged to create simulated learning

opportunities for healthcare providers and students to practice scenarios, to develop these emotional skills (Chao et al., 2018; Farra et al., 2018; Ma et al., 2021; Saab et al., 2022; Siah et al., 2022; Wijma et al., 2018). However, this emerging technology is only beginning to be explored as part of nursing and health education curricula for the purposed of developing these emotional skills, which are foundational for relational pratice.

Virtual reality has been defined in several ways. This creates confusion and lack of clarity around a common understanding of what virtual reality is. One contributing factor to this lack of clarity is the use of the terms simulation, augmented reality, and VR interchangeably. Kardong-Edgren et al. (2019) has suggested the definition of virtual reality be further clarified to include the levels of immersion based on inclusiveness, extensiveness, surrounding, vividness and proprioceptive feedback. For the purpose of this study, virtual reality has been defined as an immersive simulated experience where the user can interact within the three-dimensional, virtual environment, through multisensory modalities, using a head-mounted device and haptic technology.

1.1.2 Dementia

Currently over 50 million people around the world live with dementia, an estimated 10 million more will be diagnosed each year (WHO, 2017). The World Health Organization defines dementia as "a syndrome, usually of a chronic or progressive nature, caused by a variety of brain illnesses that affect memory, thinking, behaviour and ability to perform everyday activities" (WHO, para.1). As cognitive function declines, changes to mood, emotional control, behavior, and motivate are often observed (WHO). Dementia is an overarching term for a number of diseases or conditions which impair cognitive function. The three most common forms of dementia are Alzheimer disease, vascular dementia, and Lewy bodies (Alzheimer Society of

Canada, 2022). The signs and symptoms of different types of dementia are often mixed and overlap (WHO, 2017). Aggression may be a responsive behaviour exhibited by clients living with dementia (Alzheimer Society, 2013). Aggressive behavious can involve physical and emotional outbursts including: shouting, hitting, grabbing, harsh language, kicking (Alzheimer Society).

1.1.3 Self-Efficacy

Self-efficacy is the belief we have in our own abilities, specifically our ability to meet the challenges ahead of us and complete a task successfully (Bandura, 1993). Increased self-efficacy has been linked to the reduction of caregiver and student stress (Tang & Chan, 2016). This stress affects not only students, but also clients, and employers. Self-efficacy improves resiliency in students leading to improved patient-caregiver interactions, enhanced continuity of care, and economic benefits for the health authority (Cuartero & Tur, 2021). Measurements of self-efficacy following dementia training have shown knowledge and self-efficacy were maintained after three months, but intervention skills showed decline (Mackenzie & Peragine, 2003). New approaches for improving self-efficacy for nursing students are needed.

1.1.4 CareGiVR™ Application

CareGiVR™ is an interactive VR application which builds and improves upon existing immersive training, bringing portability and allowing for repetitive practice to increase self-efficacy and reorient as required (Bailenson, 2018). The purpose of the CareGiVR™ application is to provide a realistic training platform for students and caregivers to learn how to de-escalate an aggressive dementia client to a more baseline and controllable mood through the safe use of Virtual Reality. Existing VR training uses 360-degree video to build empathy by placing students in the client role but is limited in the range of interactions. This application leverages

performance capture technology to provide convincing interactions with virtual beings who demonstrate behavioural authenticity, natural human motion, and facial expression to offer genuine emotional responses. Features such as directional audio enhance the feeling of presence.

Users can observe and experience multiple caregiver roles, and characters are recognizable and relatable to avoid loss of scenario engagement. Virtual beings are designed to exhibit signs of anxiety and aggressive behaviour and offer a cross-section of society with varied genders, ages, and ethnicity. Simulated patient care provides the opportunity to practice repeatedly in a protected environment, to solidify skills and receive real-time feedback (Issenberg et al., 2005; Ravert 2002; Prion, 2008; Wang, 2011; Mantovani et al., 2003; Pantelidis, 2009).

The use of VR in educational institutions has the potential to offer students more access to learning opportunities in a safe environment. Students and caregivers can practice responses in a variety of scenarios, receive immediate performance feedback and repeat as necessary for ongoing iterative learning without the costs and logistical challenges of a facilitated workshop. Ideally, this feedback should result in greater breadth and depth of knowledge development, ultimately resulting in better outcomes for the client when in the practice setting. In the short-term, the use of VR could result in new graduates who have more extensive knowledge bases, skills, and attitudes than they would have previously gained.

1.2 Organization of the Dissertation

Three papers were written to address the purpose and research questions of the study. A scoping review of the current literature, discussion of the methodology and user-centered design framework, and the results of the research questions. The first paper of the dissertation is a scoping review of the use of immersive virtual reality in education for nursing students. This

manuscript identified a gap in nursing knowledge which guided the research project for this dissertation.

The second paper outlines the design and methodological considerations for using the explanatory sequential mixed methods design to answer the research questions. The paper presents the integration of the six-step user-centered design framework developed by Risling and Risling (2020) applied in this case to the creation of a digital health solution using virtual reality for caregivers to build self-efficacy to manage aggressive behaviors in clients with dementia.

The third paper reflects the quantitative and qualitative results of the study. Quantitative data were collected through online survey of the Inventory of Geriatric Nursing Self-Efficacy (IGNSE) to measure changes in perceived self-efficacy pre and post-intervention. The qualitative phase of this explanatory study was guided by an interpretive description approach using focus group interviews.

1.3 CHAPTER SUMMARY

Globally, the rates of dementia are increasing. The nursing workforce, and subsequently students who enter the profession will face continued pressure to care for the growing number of clients living with dementia. The lack of specialized education for this population could result in lower levels of self-efficacy for those providing care. Low self-efficacy among care providers can contribute to stress, absenteeism, and injury (Tang & Chan, 2016). While nursing school curricula offer theoretical and clinical practice experiences, there are limitations to the repeatability and availability of these experiences, especially when it comes to dementia care. Virtual reality is an emerging technology in nursing education which may offer a solution for building self-efficacy in dementia care for nursing students. How virtual reality, specifically the CareGiVR™ application, can influence practical nursing students' perceived self-efficacy is not well understood. Using an explanatory sequential mixed- methods design with an interpretive descriptive approach this study aims to address this gap in knowledge. This study will provide a better understanding of the use of immersive VR as a potential tool for improving self-efficacy among nursing students managing aggressive behaviors in clients with dementia.

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CHAPTER 2

Virtual reality has emerged as an innovative technology with many potential uses within the domain of nursing (Kardong-Edgren et al., 2019). Although virtual reality has contributed to improved outcomes for students and patients (Donnelley et al., 2020; Kravitz et al., 2022; Williams et al., 2020), little is known about how virtual reality is being utilized within nursing education. A scoping review was conducted to identify the available research on the use of virtual reality in nursing education, with the aim of understanding the current state of the literature on this topic. This paper adheres to the author guidelines for Nurse Education Today. This manuscript was written in collaboration with Sheri Wright, RN, MN, a nursing faculty member involved in the CareGiVR™ project scenario design. My contributions included: conceptualization, literature search, study selection, data extraction, drafting the manuscript, and incorporating feedback. Sheri Wright's contributions included study selection, data extraction confirmation and feedback on the draft manuscript. None of the articles retrieved as part of this scoping review directly focused on the use of virtual reality for improving self-efficacy in managing aggressive behaviours in clients with dementia. This manuscript identifies a gap in nursing knowledge which guided the research project for this dissertation.

2.0 Abstract

Background: Virtual reality is an emerging technology for nursing education. This technology can provide visual, motor, and auditory immersion into a virtual environment, thereby mimicking reality. Virtual reality may provide an effective pedagogical tool for nursing educators to meet the learning needs of nursing students.

Objective: The aim of this study was to review the use of immersive virtual reality as it utilized within nursing education program with nursing students.

Design: Scoping review following established methodology.

Data sources: A database search of ERIC (OVID), Medline (OVID), PubMed, Web of Science, and CINAHL Plus with Full Text, and Nursing and Allied Health Database.

Review Methods: Two reviewers independently screened titles and abstract of 2115 articles. Twelve articles were included in this scoping review.

Results: Five major themes identified in the thematic analysis included: self-confidence, skill acquisition, improved learning outcomes, perspective taking, and promoting engagement. Immersive virtual reality is being utilized in a variety of clinical settings and with different intended purposes. The majority of virtual reality research is focused on end-user satisfaction and perceptions of usability.

Conclusions: This scoping review provides a comprehensive understanding of the use of immersive virtual reality within nursing education. There are a wide range of definitions of virtual reality utilized within the nursing literature. Further research is necessary to study this growing area of technology for nursing education.

Keywords: virtual reality; nursing students; scoping review; immersive

2.1 Exploring the use of Immersive Virtual Reality in Nursing Education: A Scoping Review

Nursing faculty are consistently exploring new and innovative technologies to deliver programming which are practical, meaningful, and effective. One example of an emerging technology in nursing education is virtual reality (VR). Virtual reality can provide varied levels of immersion into a virtual environment, thereby mimicking reality. This digital tool creates the possibility of facilitating repeated access to environments and scenarios such as emergency departments, operating rooms, and long-term care facilities to meet learning outcomes.

There are many emerging definitions of VR, often creating confusion and lack of clarity. One contributing factor to this confusion may be the use of the terms simulation, augmented reality, and virtual reality interchangeably. The lack of definitional consensus for how the term virtual reality is being defined is creating complexities as to how the term is being applied within research studies. Kardong-Edgren et al. (2019) has suggested the definition of virtual reality be expanded to include the levels of immersion based on inclusiveness, extensiveness, surrounding, vividness and proprioceptive feedback. For the purpose of this review, virtual reality has been defined as an immersive simulated experience where the user can interact within the three-dimensional, virtual environment, through multisensory modalities, using a head-mounted device and haptic technology. Two variables are often considered: immersion and presence. Immersion represents the ways in which the user can interact within the virtual space through various sensory stimuli (Kardong-Edgren et al., 2019). Presence refers to the extent to which the user experiences the simulated environment (Kardong-Edgren et al., 2019). There is a need to explore how virtual reality has been used within nursing programs utilizing this definition.

2.2 Background

Traditional nursing programs include the use of theoretical learning within the classroom, and the use of clinical experiences in a variety of practice settings where students can apply their theoretical knowledge (Oermann, 2015). However, digital education technologies have become more common within nursing education programs as an adjunct to facilitate learning. One example of digital technology is VR. The use of virtual reality training programs shows evidence of success within the nursing profession (Farra et al., 2018; Smith et al., 2018) and broader health science professions (Aksoy, 2019; Dyer et al., 2018; Wilson et al., 2017). Simulated experience provides the opportunity to practice repeatedly in a protected environment, to solidify skills, and receive real-time feedback (Gurusamy et al., 2013; Kilmon et al., 2010; Kyaw et al., 2019). Immersive VR shows a positive correlation between the repeatable nature of VR simulation training on performance and demonstrates advantages in an educational context, particularly health care, where skills are continually updated (Jütten et al., 2017). Based on the variance of how virtual reality has been defined, to the best of our knowledge there is no review about how virtual reality, as defined in this review, is being used within nursing programs. Therefore, the aim of this study was to review the use of immersive virtual reality in education for nursing students.

2.3 Methods

A scoping review is a systematic form of knowledge synthesis which maps evidence to answer a research question (Arksey & O'Malley, 2005). Scoping reviews are relevant "to disciplines with emerging evidence in which the paucity of randomized controlled trials makes it difficult for researchers to undertake systematic reviews" (Levac et al., 2010, p. 1). Assessment of methodological quality is typically not performed to exclude studies based on quality scores.

Instead, analysis and reinterpretation of extant quantitative and qualitative data provide an overview of the state of the science regarding the research question (Levac et al., 2010). The methodological framework used to map studies addressing the use of immersive virtual reality in nursing education was the model of Arksey and O'Malley (2005), extended by Levac et al. (2010). Recommendations to clarify and enhance the scoping methodology include: (1) clarifying and linking the purpose and research question; (2) balancing feasibility with breadth and comprehensiveness of the scoping process; (3) using an iterative team approach to selecting studies; (4) extracting data; (5) incorporating a numerical summary and qualitative thematic analysis, reporting results, and considering the implications of study findings to policy, practice, or research; (6) incorporating consultation with stakeholders as a required knowledge translation component of scoping study methodology (Levac et al., 2010). A prior review protocol was not published. Within this methodology, the PRISMA-ScR reporting recommendations were followed for this review (Tricco et al., 2018).

2.4 Purpose and Research Question

This scoping review is an exploration of the use of immersive virtual reality in nursing education and identifies relevant gaps in the literature. The research question used to guide this scoping review was: How is immersive virtual reality being utilized in nursing education?

2.5 Identification of Relevant Studies

2.5.1 Information Sources and Search Strategy

A search of the academic literature was completed by the primary author with assistance from the university subject librarian and library guides, as necessary, within the following databases: ERIC (OVID), Medline (OVID), PubMed, CINAHL Plus with Full Text, and Nursing and Allied Health Database, and Web of Science. Databases were searched using the terms

detailed (Table 2.1), and title and abstracts were assessed to determine if articles met the inclusion criteria (Table 2.2). The key search terms were identified based on a review of relevant keywords from prior literature searches and group member expertise. The search strategy comprised two categories (nursing education, virtual reality) with multiple synonyms. Mesh-Browser was consulted for relevant terms. The search included variations of the following terms in each category and the Boolean connectors of (AND) and (OR) connected the terms in the two columns. Truncation was utilized to include all possible endings of the search term.

Table 2.1 Summary of Search Terms

Nursing education Nursing school Nursing program* (program, nursing programs) Nursing student* (student, students) Student nurse* (nurse, nurses)	Virtual realit* (reality, realities) Virtual environment VR Immersive technolog* (technology, technologies)

2.5.2 Eligibility Criteria

Inclusion criteria were completed studies with all types of qualitative, quantitative and mixed designs from 2010-2022, published in English, with full text available. Studies included enrolled nursing students (undergraduate, diploma, and certificate) and use of immersive virtual reality. Immersive virtual reality was defined as an immersive simulated experience where the user can interact within the three-dimensional, virtual environment, through multisensory modalities, using a head-mounted device and haptic technology.

Table 2.2 summarizes the inclusion and exclusion criteria.

Table 2.2 Summary of Inclusion and Exclusion Criteria

Inclusion Criteria	Exclusion Criteria
Nursing Students (certificate, diploma, degree)	Graduate programs
Use of Immersive Virtual Reality	Use of other technology
English	Device Evaluation
2010-2022	Program Evaluation
Primary Research Article	

2.5.3 Study Selection

The initial search identified 2115 articles. Results were downloaded into Endnote 20™ to enable duplicates to be identified and removed. After removing 296 duplicates, the results were exported to Microsoft Excel. 1819 titles and abstracts were reviewed independently by the co-authors with an aim to minimize selection bias. When the reviewers did not reach consensus in the initial review they met to discuss and reach a decision. 49 articles were retained for full-text analysis. Full-text articles were assessed by the lead author (LV) in consultation with the secondary author to reach consensus. Thirty-seven studies were excluded because: they did not fit the definition of virtual reality (n=30); the population did not include nursing students (n=5); the study was a review of the hardware and did not include a nursing education component (n=2). Finally, twelve articles as being relevant to the research aim and question.

2.5.4 Data Extraction and Charting

The lead author (LV) extracted the study characteristics, methodology, findings, and implications for nursing from the selected articles. Data was reviewed by the secondary author (SW). Results were clustered according to themes of immersive VR use. Since scoping reviews intend to map available literature and guide further research, studies were not subject to quality appraisal. Appendix A provides an overview of the study characteristics and main results of the included publications.

2.6 Results

2.6.1 Study Characteristics

The studies were conducted in several countries: Canada (Thompson et al., 2020); Germany (Lange et al., 2020); Ireland (Saab et al., 2022); Scotland (Adhikari, 2021); South Africa (Botha, 2021); Taiwan (Chang & Lai, 2021; Chao et al., 2021); United States (Butt et al.,

2018; Farra et al., 2018; Kardong-Edgren et al., 2019; Ma et al., 2021; Samosorn et al., 2020). Sample size varied from 12-100 nursing students. Despite an inclusion criteria of published literature from 2010 and on, 10 of the twelve studies were published within the last three years (Adhikari et al., 2021; Botha et al., 2021; Chang & Lai, 2021; Chao et al., 2021; Kardong-Edgren et al., 2019; Lange et al., 2020; Ma et al., 2021; Saab et al., 2022; Samosorn et al., 2020; Thompson et al., 2020). This finding may suggest an increased interest and access to immersive virtual reality within nursing education.

One study was a randomized controlled trial (Chao et al., 2021). Four utilized mixed-methods (Adhikari, 2021; Botha, 2021; Butt et al., 2018; Thompson et al., 2020). Four were qualitative studies (Chang & Lai, 2021; Lange et al., 2020; Farra et al., 2018; Saab et al., 2022). One was a pre-test post-test design with one group comparing the means of a knowledge test before and after the immersive VR intervention (Samosorn et al., 2020). One was a 2x2 between subjects design (Ma et al., 2021). The 2x2 design allows for comparison between two different interventions, under two different conditions. In this case, the study included both patient family members and healthcare provider's perspective in either immersive VR or a non-VR environment (Ma et al., 2021). One was a quantitative survey (Kardong-Edgren et al., 2019). The pre-test post test

2.7 Thematic Analysis

A qualitative review of the 12 articles resulted in five major themes identified in the thematic analysis included: self-confidence, skill acquisition, improved learning outcomes, perspective taking, and promoting engagement.

2.7.1 Self-Confidence

The theme of self-confidence appeared in several studies throughout the review (Adhikari

et al., 2021; Chao et al., 2018; Farra et al., 2018). Adhikari et al. (2021) found a statistically significant increase in self-confidence and decrease in anxiety for participants after engaging in an immersive VR sepsis game, this increased self-confidence was reinforced within the qualitative interviews. Within their focus groups following an immersive virtual reality simulation, participants in another study reported feeling more self-confidence and suggested the VR simulation was less intimidating than traditional mannequin-based simulation (Farra et al., 2018). Although, self-confidence to perform the skill of nasogastric tube insertion increased for the participants who used the interactive virtual reality following the VR intervention compared to their baseline, when compared with a group who viewed a traditional demonstration video there was no statistically significant difference in their level of self-confidence (Chao et al., 2018).

2.7.2 Skill Acquisition

The review revealed three studies where immersive virtual reality was utilized for skill acquisition (Butt et al., 2018; Chang & Lai, 2021; Kardong-Edgren et al., 2019). Skills included: catheter insertion, and nasogastric tube insertion (Butt et al., 2018; Chang & Lai, 2021; Kardong-Edgren et al., 2019). Because all of these skills would be considered invasive and not appropriate for students to practice on each other, or a standardized patient within the lab setting, this suggests VR may present a viable solution for invasive skills practice.

Compared with the control group, the nursing students who practiced catheter insertion using a virtual reality simulation had the same ability to demonstrate sterile technique as the students who used a traditional set-up in the school's simulation lab (Butt et al., 2018). Participants in the nasogastric immersive VR simulation felt this teaching strategy had the advantages of being less stressful and more environmentally friendly alternative for learning

skills (Chang & Lai, 2021). However, participants also expressed there was a learning curve to the VR which took time (Chang & Lai, 2021). This learning curve is also suggested by Kardong-Edgren et al. (2019) who found users who self-identified as a "gamer" found the simulation less challenging and less demanding for practicing a catheter insertion. Although these findings may suggest VR is not necessary for learning these skills, it may present a viable alternative requiring less space and consumable supplies.

2.7.3 Improved Knowledge

This theme was reflected in four studies from the review (Adhikari et al., 2021; Chao et al., 2021; Saab et al., 2022; Samosorn et al., 2020). Samosorn et al. (2020) conducted a pilot study to determine whether an immersive virtual reality simulation builds knowledge and skills for teaching airway insertion. Findings indicated a significant increase in knowledge between pretest and post-test scores and suggest VR can make a meaningful contribution to learning (Samosorn et al., 2020). Similarly, participants in the immersive VR simulation teaching nasogastric tube insertion had improved knowledge following the intervention, however, participants did not score significantly higher than those who viewed a traditional demonstration video (Chao et al., 2018). Although Saab et al. (2022) did not evaluate a specific outcome, focus group feedback suggests immersive VR may be suitable for various learning styles through the visual, audio, and motor features and limit knowledge overload. Similarly, Adhikari et al. (2021) found a positive perceived impact on knowledge and an opportunity for reflection on knowledge gaps and areas from improvement by participants.

2.7.4 Perspective Taking

The theme of perspective taking emerged during the analysis and included two studies (Ma et al., 2021 & Saab et al., 2022). Ma et al. (2021) compared playing a game in immersive

virtual reality to non-virtual reality and found participants had statistically significant higher empathy scores when playing in immersive VR. This finding is consistent with the work of Saab et al. (2022) where participants in the study suggested immersive VR would be a meaningful way to increase nurses' empathy toward patients. One participant suggested it could be used within dementia care to help healthcare workers understand how it feels to be spoken to in a child-like tone (Saab et al., 2022).

2.7.5 Promoting Engagement and Satisfaction

Several studies noted the use of immersive virtual reality made the students feel they were more engaged in the scenarios (Adhikari et al., 2021; Botha et al., 2021 Butt et al., 2018; Chao et al., 2021; Farra et al., 2018; Lange et al., 2020; Saab et al., 2022; Thompson et al., 2020). Farra et al. (2018) sought to provide new evidence in how varying levels of immersion are perceived by nursing students. Within the study, the students who engaged in a higher level of immersion, consistent with the definition in this study, reported the feeling of being present in the hospital to the extent they forgot where they were. Engagement could also be considered by the amount of time spent using the application. Butt et al. (2018) noted the students who used VR comparted to a traditional simulation lab spent a longer amount of time practicing and completed more procedures.

Although in their study, knowledge and confidence were not significantly different compared to the control group, there was a statistically significant higher satisfaction level within the group utilizing the virtual reality (Chao et al., 2021). This finding is similar to Thompson et al. (2020) where the students' qualitative responses suggest a positive experience with virtual reality, because it was more active, immersive, and realistic than passive teaching techniques. Students who participated in the virtual reality intervention conducted by Saab et al. (2022)

described the immersive virtual reality as more memorable, novel, and enjoyable than other conventional teaching methods and attributed this result to the immersion and interactive nature of the application. This theme was also present in the interview themes from Adhikari et al. (2021), Botha et al. (2021), and Lange et al. (2020) where the majority of participants felt the simulation was immersive, realistic, and interactive.

2.8 Discussion

The aim of this scoping review was to map the available nursing literature as it relates to the use of immersive virtual reality within nursing education. The results show the characteristics of available studies regarding the use of immersive virtual reality in nursing education and provide an overview of the current state of research concerning this topic. Within the scope of this review twelve studies have been published (Adhikari et al., 2021; Botha et al., 2021; Butt et al., 2018; Chang & Lai, 2021; Chao et al., 2021; Farra et al., 2018; Kardong-Edgren et al., 2019; Lange et al., 2020; Ma et al., 2021; Saab et al., 2022; Samosorn et al., 2020; Thompson et al., 2020).

The findings of this review suggest there are ongoing efforts to evaluate the impact of virtual reality within nursing education (Adhikari et al., 2021; Chao et al., 2021; Ma et al., 2021; Samosorn et al., 2020). However, a majority of the studies reported user self-perception as anecdotal feedback (Botha et al., 2021; Butt et al., 2018; Chang & Lai, 2021; Farra et al., 2018; Kardong-Edgren et al., 2019; Ma et al., 2021; Saab et al., 2022; Thompson et al., 2020).

The studies included within the scoping review reflect a variety of clinical settings including emergency (Adhikari et al., 2021; Botha et al., 2021; Samosorn et al., 2020), older adult (Ma et al., 2021; Saab et al., 2022), and medical-surgical (Butt et al., 2018; Chang & Lai, 2021; Kardong-Edgren, et al., 2019). This review also revealed that the value of virtual reality

for nursing education may be more broad than skill acquisition, and may support development of the "art of nursing" skills such as communication, empathy, and confidence (Adhikari et al., 2021; Chao et al., 2018; Farra et al., 2018;Ma et al., 2021; Saab et al., 2022).

Several studies have shown a greater level of immersion plays a part in the overall outcome of the study (Farra et al., 2018; Saab et al, 2022; Thompson et al., 2020). Conversely, two of the studies evaluating skill acquisition (Butt et al., 2018; Chao et al., 2021) did not find a significant difference in the ability to perform the skill, compared to more traditional teaching methods. Chang & Lai (2021) noted participants felt the virtual reality was lacking a sense of reality largely due to the touch sensation within the immersive VR. Although the data was not significant, because virtual reality was not found to be inferior for skill acquisition, there may still be value in utilizing this technology compared to alternatives, because of the reduction in consumable supplies, space allocation, and cost (Chang & Lai, 2021). However, cost was viewed as a barrier, not an advantage, in Lange et al. (2020). Because the focus population of this study was students, the perception of cost to a nursing program may need to be further studied with a broader population focus including academic administrators and simulation faculty. As the technology is rapidly evolving these noted deficits may become less of a barrier and thererfore consistent, ongoing research is needed.

Nursing researchers are using a variety of terminology to describe immersive virtual reality. The term was present in excluded studies, which included desktop games, augmented reality, mannequin-based simulation, and 360^0 room projection. This scoping review reinforces the recommendation from Kardong-Edgren et al. (2019) to include the level of immersion and the equipment used within the VR descriptions or definitions in all study publications to increase clarity for the reader. Despite an inclusion criteria of studies published since 2010, all of the

included studies were published since 2018. The recent increase in available research suggests VR is a new and growing area of nursing education research as the technology advances and becomes more widely available.

2.9 Limitations

This scoping review presents the current range of evidence regarding the use of immersive virtual reality within nursing education. The findings should not be generalized to other populations or contexts. The methodological quality of the studies did not influence the inclusion or exclusion of any paper in this scoping review, since this type of design provides an overview of the body of literature in a given topic without critically appraising the evidence found (Munn et al., 2018). For this reason, our findings reflect the scope use to date but cannot be used to make future recommendations with regards to any specific use of immersive virtual reality as a teaching method, nor conclusions be drawn other than those presented. Because of the variance in definitions and terminology utilized, potentially relevant articles containing the use of immersive virtual reality within nursing education may have been excluded. A broad search strategy was incorporated to mitigate this limitation. A limitation of this review is that the majority of studies were conducted with small samples in a single nursing course, at a single site, or within one geographical region. Also, only peer-reviewed published nursing education literature was included. Finally, we only reviewed English language research.

To conduct a more comprehensive review of the use of immersive virtual reality in nursing education the scope should be expanded to include graduate level programs and continuing education. Future reviews could include the use of varied levels of immersion.

2.10 Conclusion

This scoping review provides a comprehensive understanding of the use of immersive

virtual reality within nursing education. Because only twelve studies met the review inclusion criteria, this suggests there is a gap within the literature related to the use of immersive virtual reality in nursing education. Despite some findings which did not find VR to be a superior teaching modality overall, the studies included in this review did report largely positive outcomes with virtual reality use in nursing education.

2.11 Chapter Summary

At the time of the scoping review, no research had been conducted specifically exploring the use of virtual reality for improving self-efficacy in managing aggressive behaviours in clients with dementia**.** Therefore, this scoping review supported the overall research question. Five major themes identified within the scoping review included: self-confidence, skill acquisition, improved learning outcomes, perspective taking, and promoting engagement.

Since undertaking the review, two additional studies have been found which satisfy the inclusion criteria, both published in summer 2022 (Chu-Ling, 2022; Siah et al., 2022). Chu-Ling (2022) evaluated student satisfaction on the use of an immersive VR simulation to practice performing Foley catheter insertion on female patients. Using a quasi-experimental design 43 post-baccalaureate nursing students participated in the intervention and follow up questionnaire and focus groups. The findings from this study are consistent with the themes from the scoping review and suggest students felt the VR simulation was enjoyable and an effective way to learn the skill. The study took place in Taiwan.

The second study by Siah et al. (2022) evaluated the efficacy, attitude and confidence of 207 nursing students in a virtual perioperative setting designed to teach patient safety procedures. The study used a single-group descriptive study design. Findings suggest students either felt neutral or positive about the use of virtual reality toward their efficacy, confidence and attitudes. The study notes the students with previous experience using VR reported higher scores in all domains, and highlights the importance of adequate orientation on how to use the technology (Siah et al., 2022). This finding is consistent with Saab et al., (2020) who found participants who had not utilized VR before responded less favorably to the technology.

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Table 2.3 Study Characteristics						
Authors (year)	Country	Aim	Methodology	Participants/Population	Findings	Implications for Nursing
Adhikari, Kydonaki, Lawrie, O'Reilly, Ballantyne, Whitehorn, Paterson, R. (2021)	Scotland	Evaluate the effects of the immersive virtual reality game on self-efficacy with pre-registration nurse and explore perceptions of acceptability and applicability of the game in nursing education	Mixed-methods sequential 1. Pre-test post test intervention using Nursing Anxiety and Self-Confidence with Clinical Decision Making sale. 2. Descriptive qualitative approach exploring student nurses' perceptions of the game	19 3rd year pre-registration nurses ages 25-45	26.1% increase in mean confidence score post-intervention and 23.4% decrease in anxiety. Four broad themes were generated: Acceptability, Applicability, Areas of Improvement and Limitations	Findings suggest the VR intervention increases confidence and reduces anxiety when caring for a person who is showing signs of deterioration due to sepsis. The game shows promise as a pedagogical approach
Botha, de Wet, Botma (2021)	South Africa	Provide insight into South African nursing student experiences while being immersed in a virtual environment managing a	Mixed-methods concurrent design; observational data and questionnaire	34 3rd year undergraduate nursing students (6 pilot tested)	Experiences were mostly positive. Some students experienced dizziness, nausea and feeling off-balance. Students found the virtual	The scenario was useable to the extent the nursing students felt they would benefit from this as a teaching and learning method

		foreign object in the airway			environment to be realistic, easy to use, and comfortable to wear.	
Butt, Kardong-Edgren, Ellertson, (2018)	United States	Explore the usability of, and user reaction to a game-based VR system designed to practice urinary catheter insertion	Mixed-methods post-intervention System Usability Survey and user-reaction survey. Two week follow-up return demonstration	20 junior-level undergraduate nursing students in their 5th or 6th semester	VR game was helpful, fun, engaging and preferred over a task-trainer; there was no difference in ability to demonstrate the skill in the two-week follow-up between the experimental and control groups	VR may provide a new way to help students deliberately and repetitively practice procedural skills, potentially leading to greater skill retention
Chang & Lai, (2021)	Taiwan	To understand the experience of nursing students in using virtual reality skill learning process	Qualitative focus groups with content analysis	60 nursing students (55 women 5 men) from a two-year program	Students found the VR convenient but had to adapt to the VR. They could learn the skill quickly, it was stress free and environmentally friendly. Students felt the VR lacked a sense of reality	VR may be a supportive learning tool for nursing students but still lacks a sense of reality and does not fully replace traditional teaching methods

					compared to conventional teaching methods	
Chao, Hu, Chiu, Huang, Tsai, & Chuang, (2021)	Taiwan	Examine the effects of an immersive three-dimensional (3D) interactive video program on improving nursing students' nasogastric tube feeding skill competence.	Randomized controlled trial	45 nursing students from a university in northern Taiwan	Although there were no significant differences in students' knowledge, skill, and confidence between the two groups, participants' average satisfaction score with the immersive 3D interactive video program in the intervention group was significantly higher than in the comparison group that watched a regular video	Both immersive 3D interactive video program and regular demonstration video could improve nursing students' learning outcomes. This study provides useful information for nursing faculty members for designing and developing teaching methods for the acquisition of nursing skills.
Farra, Smith, & Ulrich, (2018)	United States	To provide new evidence in how varying levels of immersion are	Qualitative focus groups with content analysis	100 senior baccalaureate nursing students	Students in moderate and high immersion identified positive learning	Varying levels of virtual reality simulation demonstrate equal or improved

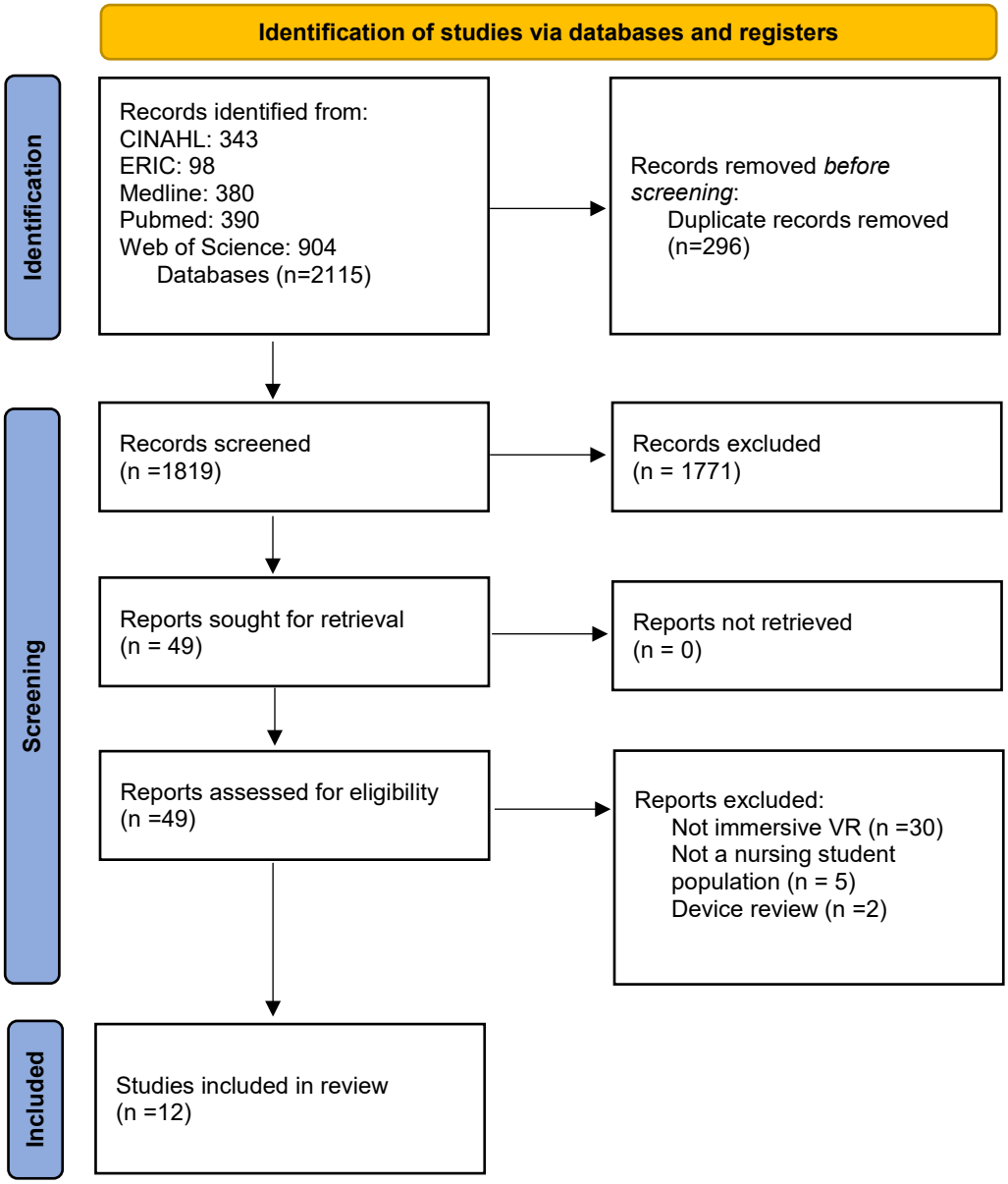
		perceived by nursing students using disaster-based virtual reality experiences			experiences. Participants enjoyed the experience, felt comfortable learning, and were impressed with the level of realism	learning outcomes with higher levels of immersion
Kardong-Edgren, Breitkreuz, Werb, Foreman, & Ellertson, (2019)	United States	To evaluate the usability of a VR game system for sterile catheterization practice.	Quantitative survey	29 Undergraduate junior and senior nursing students and two nursing faculty	Seventy-five percent of participants rated the game as positive overall on the User Reaction Survey. Left-handed players had more difficulty playing the game. Players with prescription glasses could not comfortably place the Oculus Rift over their glasses to play	Usage of the game was positive and entertaining. A left-handed version of the game and provision for glasses wearers would enhance the usability of the game
Lange, Koch, Beck, Neugebauer, Watzema, Wrona, & Dockweiler,	Germany	To observe the degree of acceptance of VR applications by nursing	Qualitative semi-structured open-ended interviews	12 nursing students who had taken anatomy (4 male 8 female)	VR was rated positively. The higher the personal affinity the more useful the technology	VR programs can be an important, supporting part of the training to deepen learning i.e. anatomy. The

(2020)		students in Germany			appears. Motivation to learn was increased by using VR. Cost is still a barrier	technology has to be easy to use and understandable to lead to great affinity and acceptance
Ma, Huang, & Yao, (2021)	United States	To investigate the feasibility and effectiveness of a computer role-playing game on nursing students' empathy with a focus on immersiveness and perspective	Quantitative 2x2 between-subjects design	69 undergraduate nursing students from two universities	Playing the game in VR led to greater spatial presence and empathy. Playing in the health care provider's perspective elicited greater empathy, when compared to the patient family perspective.	Using VR in empathy training through perspective taking my improve nursing students' empathy
Saab, Landers, Murphy, O'Mahony, Cooke, O'Driscoll, & Hegarty, (2022)	Ireland	To explore nursing students' views of using virtual reality in healthcare	Qualitative descriptive study guided by naturalistic inquiry	26 third year undergraduate nursing students from two programs	Participants described this technology as novel, enjoyable, immersive, memorable and inclusive. They questioned, however, the suitability of virtual reality for older adults, reported minor	Virtual reality was recommended for use in outpatient healthcare settings, schools and the community. Participants suggested using virtual reality in health promotion, disease prevention

					technical difficulties and stressed the importance of prior preparation in the use of the technology.	and management, and to promote nurses' empathy towards patients.
Samosorn, Gilbert, Bauman, Khine, & McGonigle, (2020)	United States	To examine whether an educational intervention with a pilot contemporary immersive virtual reality simulation builds knowledge and is feasible to implement among nursing students and faculty	Quasi-experimental one-group pretest-post-test design combined with survey sampling	10 faculty members and 21 nursing students	Faculty and students rated the VR airway laboratory as having high presence, no cyber sickness, and significant improving knowledge of airway management	VR can be used as an intervention in nursing education
Thompson, Thompson, & McConnell, (2020)	Canada	To describe students' engagement and experiences with virtual reality in a first-year nursing course on anatomy,	Mixed-methods concurrent design	46 first year undergraduate nursing students	Students perceived their engagement to be higher in virtual reality compared to other teaching methods. Their experiences were positive with	Virtual reality is an accessible tool for supporting student engagement. The Exploratory Learning Model is a useful conceptualization for integrating

		physiology, and health assessment			students reporting that they found it easy to use, it helped their learning, and they recommended more of it.	virtual reality into a course.

Figure 2.1 PRISMA Flow Chart of Included Articles



CHAPTER 3

This paper outlines the design and methodological considerations supporting the use of an explanatory sequential mixed methods design to address the proposed research questions in this study. The paper also details the integration of the six-step user-centered design framework developed by Risling and Risling (2020) applied in this case to the creation of a digital health solution using virtual reality for caregivers to build self-efficacy to manage aggressive behaviors in clients with dementia.

With consideration of the study purpose, two other theoretical frameworks were also reviewed prior to the selection of the Risling and Risling (2020) approach. A brief discussion of each of these, the socio-technical systems theory, and Goosen's framework for nursing informatics research follows.

The socio-technical systems theory originated from the coal-mining industry in the 1950s (Trist & Bamforth, 1951). The theory provides a framework for understanding the relationship between person and technology (Trist & Bamforth, 1951). While the theory was initially applied to machinery, it has since been applied to computers and digital technologies (Booth et al., 2017). The socio-technical systems theory has three main subsystems: social, technical, and environmental, which all interact (Abbas & Michael, 2022). One of the strengths of this theory was the emphasis on the social context for new technology implementation. Often the successful implementation of new technology depends on the considerations of the end-user. The socio-technical systems theory provides a framework for nursing researchers to explore user-centered research questions (Abbas & Michel, 2022). One limitation to this framework was the heavy emphasis on the social subsystem and the relationship between users. The CareGiVR^{TM} application was primarily designed for individual use and the study focus was not on the

interactions between users as part of a larger group. This was the main impetus to not consider this theoretical framework as part of the design and implementation of this study.

Goosen's framework for nursing informatics research is a patient-oriented model which includes the nurse's role in collecting and organizing data to make clinical decisions (Goosen, 2000). One of the strengths of Goosen's framework for nursing informatics research was the recognition of nursing knowledge as distinct and worth exploring. The model places value on the context in which nursing takes place to shape decisions about the design and implementation of technology (Effken, 2003). Initially, this was what drew me to exploring this framework further because of the close alignment with epistemological underpinnings of interpretive description. However, the main limitation of using this framework for this study was that ultimately it is a decision-making framework (Goosen 2000). The main focus of the model is the action taken by the nurse and the evaluation of the subsequent health outcome (Goosen, 2000). Goosen's framework did not lend itself to meaningfully guide the analysis of the research questions proposed in this study, which were focused around student perceptions through a non-evaluative intervention.

Ultimately, the theoretical framework proposed by Risling and Risling (2020) was determined to be the best fit for the study design because it bridges elements of software development best practices, with interpretive description qualitative methodology to support nurses to take a user-centered approach to developing digital health solutions. The framework is discussed in detail in the body of the paper.

This study was part of a larger project funded through Alberta Innovates xR Health Economic Acceleration and Development (xR HEAD) Program which launched in Fall 2019. The program aimed to have research teams jointly develop extended reality (xR), including

virtual reality, innovations to enhance patient care or support the training of health professionals (Alberta Innovates, 2019). Partnerships comprised of post-secondary institutions in Alberta and corporations, health delivery agents, or public health agencies were eligible to apply for this competitive grant. Though a partnership between Lethbridge College and Red Iron Labs Ltd. the project 'CareGiVR ^{TM}: Building self-efficacy in dementia care through immersive education' was funded successfully for $250,000 over two years (2020-2022). Members of the research team included registered nurses, recreation therapists, members of the computer science and virtual reality programs faculty, and software developers from Red Iron Labs Ltd. The objectives of the project were: to increase the ability for caregivers to meet the challenges in managing aggressive behaviours associated with dementia and, to lower healthcare systems expenditures for dementia care through lower disability claims, lower stress-related caregiver hospitalizations, less staff turnover, and lower training costs over time.

To qualify for funding the project was required to include at least one testable hypothesis based on an established evaluation criteria, and present sound methodology that will test the hypotheses and inform any barriers to adoption (Alberta Innovates, 2019). The information presented in this paper illustrates the philosophical, methodological, and ethical considerations for applying the CareGiVR^{TM} virtual reality intervention within the practical nursing student population to test the evaluation hypothesis. Within the following manuscript, generalities about the aforementioned research team are shared as appropriate for publication. My contributions included: design and implementation of the research study, drafting the manuscript, and incorporating feedback. This paper has been written and formatted to adhere to the author guidelines for the Canadian Journal of Nursing Informatics

3.0 Abstract

Nurses from all backgrounds can contribute purposefully and meaningfully to the development of digital health solutions for clients. Although virtual reality is an emerging field within health care, it has shown to be an effective and versatile technology for education and healthcare. The aim of this paper is to demonstrate the application of the six-step user-centered design framework developed by Risling and Risling (2020) to create a digital health solution using virtual reality for caregivers to build self-efficacy to manage aggressive behaviors in clients with dementia.

Keywords: virtual reality; user-centered design, nursing students

3.1 Application of a User-Centered Design Framework to Develop and Evaluate a Digital Health Solution

There are many areas within healthcare where technology may offer a digital solution to a health challenge. Nurses have the aptitude to make meaningful contributions to the design of these solutions through their disciplinary-specific knowledge and patient-centered care models. One growing area where nurses can engage in the design process is virtual reality. Over the past few years, virtual reality has been utilized within nursing and nursing education to support better outcomes for clients (Adhikari et al., 2021; Botha et al., 2021; Samosorn et al., 2020). Within the older adult population researchers have explored the use of virtual reality for enrichment (Chaze et al., 2021; Riaz et al., 2021) and physical functioning (Corregidor-Sánchez et al., 2020; Molina et al., 2021). Many studies using virtual reality have examined older adults as the focus population, rather than the nurses and nursing students who provide care for this population, including meeting specialized needs such as dementia support. However, there remains a gap as to the potential for this technology to increase self-efficacy for students and to manage aggressive behaviours associated with dementia. The aim of this paper is to detail the application of a user-centered design framework (Risling & Risling, 2020) to create and evaluate a virtual reality solution for practical nursing students to build self-efficacy in managing aggressive behaviors in clients with dementia. Through the six-step framework outlined by Risling and Risling (2020) the primary purpose of this paper is to outline the design and methodological decisions within the CareGiVR^{TM} project.

3.2 Theoretical Framework

Nurses can play a significant role in creating digital health and technology solutions. However, until recently, nursing education has not included competencies for technology design,

use, and evaluation (Forman et al., 2020). As a result, many nurses may feel hesitant to venture into digital health technology development, leaving nursing underrepresented in the design process (Risling & Risling, 2020). As a patient-centered profession, nurses have significant disciplinary knowledge to contribute to the design of digital health solutions for patients. The analytic framework proposed by Risling and Risling (2020) bridges elements of software development best practices with interpretive description qualitative methodology to support nurses to take a user-centered approach to developing digital health solutions. The recommended process in the framework is outlined in six steps: (1) Problem identification, (2) Technology solution hypothesis/research question, (3) Data collection and analysis, (4) Intervention Design, (5) Intervention solution building or development, (6) Testing the effectiveness (Risling & Risling, 2020). Each of these steps will be reviewed in the follow sections in relation to the CareGiVR™ project.

3.2.1 Problem Identification

Over the next three decades, the global number of older persons is projected to more than double, reaching over 1.5 billion in 2050 (World Health Organization, 2019). The number of adults worldwide with dementia could rise from about 57.4 million in 2019 to 152.8 million by 2050, driven by factors like midlife obesity, smoking, and social isolation (GBD 2019 Dementia Forecasting Collaborators, 2022). This change reflects an overall projected increase of 166% of adults worldwide with dementia. To meet the growing need for specialized dementia care the future nursing workforce, students, will need the necessary knowledge, skills and attitudes. With this population shift looming, available literature suggests nursing schools should increase effective and evidence-based interventions to continue improving nursing student competencies to care for people with dementia (Cariñanos-Ayala, 2022). Current training for students is mostly

limited to theoretical delivery and clinical practicum teaching methods, with limited opportunity to develop competence through repetition (Alushi, 2015).

3.2.2 Technology solution

A Canadian provincial funding competition invited research teams comprised of post-secondary researchers and industry partners to propose virtual reality innovations. Research teams consisting of post-secondary researchers and industry partners were invited to seek funding to develop virtual reality innovations to enhance patient care or support the training of health professionals. Through several brainstorming sessions and a review of the literature including health trends, and current challenges, an interdisciplinary team consisting of registered nurses, recreation therapists, virtual reality experts, and software developers secured funding to develop an immersive virtual reality educational innovation to better equip caregivers with the knowledge, skills and abilities to manage aggressive behaviours associated with dementia: CareGiVR™.

CareGiVR™ is an interactive VR application, which builds and improves upon existing immersive training, bringing portability and allowing for repetitive practice to increase self-efficacy (Bailenson, 2018). Increased self-efficacy, the belief in our ability to meet challenges, has been linked to the reduction of caregiver stress (Tang & Chan, 2016). Caregiver stress affects not only formal caregivers, but also clients and families. Within the formal caregiver setting, the Canadian Mental Health Commission has noted 46% of nurses reported workplace violence during their five most recent shifts and perceive that almost 50% of negative physical and verbal experiences occur during care of clients with dementia (Roussy, 2016; Speroni et al., 2014). These challenges are likely contributors to stress related illness among formal caregivers which can result in absenteeism, prolonged leaves of absence, and disability. Excess health costs for

caregivers is estimated to rise to $979,197,580 in Canada by 2038 (Alzheimer Society of Canada, 2010). Rates of absenteeism for nurses working with clients with cognitive challenges, including dementia, are among the highest for heathcare workers, and contribute to staffing shortages, which lead to overtime expenditures (Ticharwa et al., 2019). As a result, there is inconsistency of care for the client (Lipton, 2018; Ticharwa et al., 2019). One in three disability claims in Canada is related to mental illness, representing 70% of total disability claims, and more than $6 billion in lost productivity (Mental Health Commission of Canada, 2017).

Self-efficacy is anticipated to improve resiliency in formal caregivers leading to improved patient-caregiver interactions, enhanced continuity of care, and economic benefits for the health care system (Cuartero & Tur, 2021). In pursuing this VR solution, the study team sought to answer the question: How might we increase individual self-efficacy for caregivers managing aggressive behaviours associated with dementia?

3.2.3 Data Collection and Analysis

The data collection followed by the intervention design and development did not subscribe to a linear trajectory within the project. Instead, all three steps within the Risling and Risling (2020) framework took place concurrently over the span of two years through an iterative process. Members of the research team with disciplinary-knowledge related to dementia care initially developed scenario storylines for the avatars to become actualized within the immersive virtual reality by the software developers. Guided by best practice resources, personal experience, and stakeholder consultation, three initial scenarios were refined and actualized into an interactive VR simulation. Design considerations from the software development experts were also considered for elements of functionality and feasibility. The resulting application was the CareGiVR™ platform.

3.2.4 Intervention Testing

An explanatory sequential mixed methods design was used to address the following research questions for this study:

(1) Does perceived self-efficacy improve for practical nursing students who use the CareGiVR™ application compared to those who do not, in relation to managing aggressive behaviors in clients with dementia?

(2) Are there significant differences between practical nursing students' perceived self-efficacy with managing aggressive behaviors in clients with dementia before and after using the CareGiVR™ application?

(3) How did practical nursing students perceive using the CareGiVR™ application influenced their self-efficacy with managing aggressive behaviours in clients with dementia?

3.2.4.1 Rationale for Mixing Methods

Mixed-methods research has emerged in the applied health sciences as a new opportunity to create knowledge using both qualitative and quantitative methods (Creswell, 2011). Rather than subscribing to an exclusively post-positivistic or constructivist paradigm, mixed-methods researchers aspire to integrate rich qualitative understanding with broad generalizations (Patton, 2015). The underlying assumption of mixed-methods research is that "the combination of qualitative and quantitative approaches provides a more complete understanding of a research problem than either approach alone" (Creswell, 2014, p. 5). Rather than suggesting that an exclusively qualitative or quantitative approach is best, mixed-methodology studies act as a sort of "quality control" on one another to keep the other in check and triangulate findings (Thorne, 2016). One main assumption of utilizing a mixed-methods approach to research is that subscribing only to a qualitative or quantitative methodology would not provide a sufficient

understanding of the research problem. By thoughtfully integrating both qualitative and quantitative data the researcher can provide a more comprehensive understanding of the research issue (Creswell, 2011).

Mixed methodology has been met with some criticism on the basis that qualitative and quantitative methodologies are incompatible on epistemological levels (Teddlie & Tashakkori, 2012). There have been multiple stances on how to incorporate paradigms into mixed methods. A dialectic stance advocates for the use of multiple paradigms in one study linked to the relevant part of the research design (Creswell, 2011). Others advocate for using one underlying paradigm throughout the study and often look to pragmatism. Creswell (2014) explains that pragmatists focus on the problem rather than the method and use the necessary approaches and techniques to meet their needs. Pragmatism results in an understanding that no methodology is inherently better than another (Denzin & Lincoln, 2018). Rather, the pragmatic researcher places the research question as the main focus of importance and makes design decisions based on what will work best to answer the research question. Studies with a pragmatic research philosophy, such as this one, may use a combination of both qualitative and quantitative research methodologies to provide a more complete understanding.

When engaging in mixed methods research regardless of how the paradigms for research are incorporated, it is essential for the researcher to be upfront about their philosophical stance and stay consistent to the assumptions of the paradigm they have chosen. This consistency is partially done by making logical design choices and conclusions. Within the mixed-methods explanatory design the quantitative piece is followed by the qualitative (Creswell, 2014). The intent of the explanatory sequential design is for the quantitative data to provide a general understanding of the research problem and the qualitative analysis to allow for a more in-depth

exploration and understanding of the participant's views providing context to the quantitative data (Bowen et al. 2017; Ivankova et al., 2006).

When making design decisions for the research study the researcher must consider the data collection methods and the timing of the research phases (Creswell & Plano Clark, 2018). In this study, the purpose was to understand whether there were differences in perceived self-efficacy for students who used the CareGiVR™ application. Since quantitative data provide a means for statistical analysis and determining the significance of these differences it was appropriate to utilize a quantitative methodology as the priority method in this study. The subsequent qualitative data provided an in-depth understanding of the quantitative results and explored the perceptions and experiences of the participants.

The researcher needs to consider when to integrate the quantitative and qualitative methods into their study (Creswell & Plano Clark, 2018). In this study the methods were integrated at three stages. First, the purpose and the three research questions dictated the need for both quantitative and qualitative data. Second, based on the research questions the study followed an explanatory sequential design. The quantitative survey data was collected first and informed the semi-structured interview guide. Finally, the quantitative and qualitative findings both informed the discussion and implications for nursing.

Guided by analytical framework proposed by Risling and Risling (2020), interpretive description (ID) and its methodological underpinnings provided a useful qualitative methodology to generate findings with clinical utility (Thorne, 2016). Interpretive description emerged from an identified need for a unique nursing research methodology to generate "credible and meaningful disciplinary-specific knowledge" (Thorne et al., 2004, p. 2). The foundation of interpretive description is to investigate a clinical phenomenon of interest to discover themes and

patterns informed by subjective perceptions, while also considering individual variations (Thorne et al., 1997). This practical stance of finding what works to answer a research question aligns with the flexibility of interpretive description within a user-centered design. Thorne (2016) is a supporter of using ID techniques within a pragmatic paradigm to support a mixed-methodology design. Pragmatists do not subscribe to one branch of philosophy and rather choose the techniques and methods that work to answer their question; for this reason, the researcher is less limited in their study design choices (Creswell, 2014).

In operationalizing this mixed methods approach, the first and second research questions previously detailed were answered using quantitative survey data collected using the Inventory of Geriatric Nursing Self-Efficacy (IGNSE) (Mackenzie & Peragine, 2003). Research question three was answered using qualitative data from focus groups.

3.3 Ethical Considerations

The study protocol was approved by the Behavioural Research Ethics Board at the both the participant and researcher's institution. One of the primary ethical considerations was the previous employment of the study lead by the institution where the student participants were recruited. In order to mitigate issues of power and influence recruitment for the study was managed through an administrative assistant who sent an email invitation out to the student body. This prevented the researcher from acquiring access to class rosters or the learning management system. The researcher was not in an evaluation or supervisory role with the target population during their previous employment at the institution. All participants were required to read and sign an informed consent form before entering the study, with the understanding they may withdraw at anytime. All data storage requirements were maintained, keeping information with identifiable information secured in adherence with the guidelines from the institutional

ethics review board. COVID-19 cleaning protocols as stipulated by the Occupational Health and Safety team at the institution were be followed including: masking, social distancing, cleaning, disinfecting, and keeping contact tracing logs. Based on recommendations to minimize close contact because of the COVID-19 virus, all focus groups and surveys were conducted virtually within a password protected Zoom platform.

3.4 Quantitative Phase

3.4.1 Sample

A convenience sample of approximately 100 first-year students enrolled in the practical nursing diploma program at a public college in mid-western Canada were invited to participate in the study. Students must have received some theoretical knowledge of dementia, which took place within the curriculum during the same semester in January-February 2022.

3.4.2 Recruitment

Administrative assistants, who are a non-evaluative, non-academic role within the post-secondary institution managed the email invitations and reminders for the students to consider being part of the study. As a second recruitment strategy the principal investigator attended all lab courses and introduced the project providing an overview and encouraging students to participate. The researcher was not at anytime employed by the post-secondary institution or in a supervisory or evaluative positon over any of the students in the practical nursing program.

3.4.3 Instrument

To measure changes in self-efficacy, the Inventory of Geriatric Nursing Self-Efficacy (IGNSE) (Appendix E) was administered during three points of data collection (Mackenzie & eragine, 2003). The Inventory of Geriatric Nursing Self-Efficacy is a nine item Likert scale (Mackenzie & Peragine, 2003). This scale consists of nine items assessing self-perceptions of the

degree of confidence one has in dealing with workplace challenges (Mackenzie & Peragine, 2003). There are three items for each of the following scales: teamwork, resident, and family challenges. For each item participants are asked to rate their confidence to remain calm, resolve the problem, and achieve a positive outcome (Mackenzie & Peragine, 2003). Each item was rated on a seven-point Likert-type scale from "not at all confident" to "very confident". The survey was administered to collect baseline data, again following the CareGiVR™ simulation and finally after the clinical rotation concluded. Individuals within the control group completed the IGNSE at baseline and following their clinical rotation.

3.4.4 Validity and Reliability

The psychometric properties for the inventory include a Cronbach's alpha of 0.96 and average item–total correlation of 0.83 (Mackenzie & Peragine, 2003). This suggests the scale has a high level of internal consistency. Analysis was carried out using IBM SPSS (Statistical Package for the Social Sciences) version 28.

3.4.5 Data Collection Procedure

Students received theoretical instruction during a practical nursing theory course, with a focus on chronic illness and geriatric care, taught by a full-time continuing faculty member and nurse who is registered in good standing through their accrediting body in Alberta. Participants were randomly assigned to either a control or intervention group. Both sets of study participants completed their IGNSE using the institutional Survey Monkey software to collect baseline data. Students who were part of the intervention cohort then participated in the CareGiVR™ simulation and repeated the IGNSE immediately afterwards. All students were provided the opportunity to practice communication skills with clients experiencing dementia under the supervision of a clinical nursing instructor. At the end of the experience, the IGNSE was re-

administered to both the control and intervention group. In total, there were three points of data collection for the interventional group and two points of data collection for the control group. When a student participated in the simulation, a user log was automatically generated of all responses and actions taken. This record provided a secondary source of quantitative data which the researcher analyzed and contributed to data triangulation.

3.4.6 Data Analysis

A paired samples t-test was conducted to see if the practical nursing students' self-rated scores changed before and after the VR simulation, and after their 144 hours of clinical practice in the long-term care environment. An independent samples t-test was conducted to see if there was a significant difference in perceived self-efficacy between students in the intervention and control groups after their clinical experience. The t-test is a test of statistical significance of the difference between two sample means (Powers & Knapp, 2011). The researcher reviewed the user logs for identification of patterns and trends to further understand the participants' experiences.

3.5 Qualitative Phase

This phase consisted of virtual student focus groups. Questions were developed based on the results of the quantitative analysis and refined with peer-review from the interdisciplinary team.

3.5.1 Setting

Focus groups were conducted virtually and students were able to log on from the location of their choosing. The online video conferencing platform was password-protected to ensure the confidentiality of the participants and that only recruited participants could join. The focus groups occurred after the clinical rotation, which was scheduled until the last day of the final

examination window, no data collection occurred while the students were still in classes.

3.5.2 Sampling procedure/strategy

When students from the intervention group completed the post-clinical survey, they were informed they would receive an email invitation to participate in a follow up focus group. Because only students who participated in the CareGiVR™ application were invited to complete the survey the students had already met the inclusion criteria for the study.

3.5.3 Data Collection and Procedure

The next phase of the qualitative process was conducting semi-structured focus groups using the refined questions. Focus groups are well suited for explanatory studies as collective discussion may elicit more viewpoints than an individual interview (Kvale & Brinkmann, 2015). The suggested size of the focus group varies in the literature. Kvale and Brinkman suggest a range of 6-10 participants. Doody et al. (2013) suggest that while a groups size may range from six up to fourteen a larger group may more difficult for a novice researcher to moderate. Once the themes from the analysis of the focus group data provided a narrative to answer the research question, in a way which was clinically useable, it was determined enough participants had been interviewed (Thorne, 2016).

3.5.4 Data Analysis

Qualitative thematic analysis was guided by the analytic framework proposed by Risling and Risling (2020). Grounded in the principles of ID, the framework uses the principles of software design to guide the functional and non-functional features of the technology for the development team (Risling & Risling, 2020). The framework is non-prescriptive, however, it facilitated extraction of data which supported the design and refinement of the developing technology, in this case the CareGiVR™ platform. Use of the analytical framework was well-

suited for studies where a proposed technology provided a solution to a clinical problem. In this case the clinical problem was perceptions of self-efficacy for students managing aggressive behaviours in clients with dementia and the solution was the CareGiVR^{TM} platform. The Risling and Risling (2020) analytic framework provided a mechanism for analysis of the data to consider the technical aspects of the design, as well as the end-user's experience.

3.6 Trustworthiness

The trustworthiness of the qualitative phase was determined by considering the criteria Thorne (2016) outlines including: disciplinary relevance, moral defensibility, pragmatic obligation, contextual awareness, and probable truth.

Disciplinary relevance is concerned with whether the knowledge is appropriate for the disciplinary science (Thorne, 2016). This disciplinary relevance has been demonstrated by conducting a review of the literature and considering the patient demographic. Because there was funding available through and external granting agency this further validates the relevance of the work being done to find digital solutions.

Moral defensibility occurs when the researcher can support the rationale for the whether it is necessary to extract knowledge from the population and what the potential benefit is. This project demonstrates moral defensibility because the CareGIVR^{TM} project can potentially lower aggressive response incidents within the client population and support better outcomes for caregivers and clients. As the student population enters the workforce with this training it may lead to less health-related illness including absenteeism, decreased expenditures through lower disability claims, lower stress-related caregiver hospitalizations, less staff turnover, and lower training costs over time. Health regions could see indirect efficiencies with reduced informal caregiver stress, allowing for extended home care and lower emergency admissions to acute care

beds by overwhelmed caregivers.

The third perspective of credibility is pragmatic obligation, which expects the researcher will consider their findings as if they may be applied in practice (Thorne, 2016). Therefore the researcher should present their findings in a way which considers the potential application within the client population and the potential for harm. Within this study the findings presented demonstrate both the strengths and limitations of the CareGIVR™ project with sufficient detail about the setting, population and methodology to allow the reader to make an informed decision about the applicability of the findings to their context. Contextual awareness is determined by the researcher recognizing the interpretation of the proposed reality exists only as it is in the moment and will not necessarily stand the test of time (Thorne, 2016). The project considers contextual awareness with the recognition that technology is often changing and evolving. The use of the Risling and Risling (2020) framework for user-centered design helps the research stay oriented within the current design needs while recognizing there is a life-cycle to software and the technology may evolve so as to generate new clinical findings within the future.

The use of a framework to guide design decisions has aided in providing a transparent and logical approach to generating new knowledge. Within the methodology, triangulation of data sources including survey, user logs, field notes and focus-group interviews provided a more comprehensive understanding of the clinical phenomenon. Probable truth requires researchers to deeply reflect on the decisions, claims and implications of the project in future practice (Thorne, 2016). Thorne (2016) recommends researchers document any background thoughts, questions or ideas as they emerge. For this study, Appendix H provides a transcribed sample of the researcher's field notes. While these field notes may not be considered formal data they provided a means of tracking reflections and contributed to the overall interpretation of the data as the

research unfolded.

3.7 Implications for Nursing

The use of CareGiVR™ for nursing students could lead to increased self-efficacy when managing aggressive behaviors in clients with dementia. As students graduate, the long-term implications could include employers and health systems experiencing a shift in expenditures through lower disability claims, lower stress-related caregiver hospitalizations, less staff turnover, and lower training costs over time. Current training solutions are not meeting the ongoing training needs of dementia caregivers, lacking immersion, repeatability and affordability. This problem is only likely to become more acute as global dementia rates rise. Healthcare students, especially nurses, are entering into stressful care situations without enough previous contact and experience in managing clients who are potentially dangerous individuals. Without the opportunity for students to better develop the needed intuitive responses required for this care through repeated practice, the risks for low self-efficacy in future interactions with dementia patients in the care setting remains high.

3.8 Conclusion

Nurses are well positioned to play an active role in shaping the future of digital health. As demonstrated in this paper, the user-centered design framework proposed by Risling and Risling (2020) provides a systematic way for nurses to integrate functional and non-functional design characteristics while considering the end user in the development of new technologies. The CareGiVR™ application is an exemplar of how an interdisciplinary team applied this framework to create and evaluate a digital solution to a relevant health problem. Through thoughtful consideration of the design and methodological process the CareGiVR™ application has the potential to increase increased self-efficacy of nursing students tasked with managing aggressive

behaviors in clients with dementia.

3.9 Chapter Summary

This chapter detailed the application of the user-centered design framework developed by (Risling & Risling, 2020) to create a digital health solution using virtual reality for caregivers to build self-efficacy to manage aggressive behaviors in clients with dementia. The CareGiVR™ project is an immersive virtual reality application where the user can interact with virtual beings through a scenario designed to mimic experiences the user may have when caring for a client with dementia. To test whether the CareGiVR™ application improves self-efficacy in the practical nursing student population a mixed-methods explanatory sequential design was used. The information presented in this paper detailed the design of the study, types of data collected, ethical considerations and philosophical considerations that directed the final operationalization of this research.

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CHAPTER 4

This chapter details the results of the following research questions addressed within this study:

(1) Does perceived self-efficacy improve for practical nursing students who use the CareGiVR™ application compared to those who do not, in relation to managing aggressive behaviors in clients with dementia?

(2) Are there significant differences between practical nursing students' perceived self-efficacy with managing aggressive behaviors in clients with dementia before and after using the CareGiVR™ application?

(3) How did practical nursing students perceive using the CareGiVR™ application influenced their self-efficacy with managing aggressive behaviours in clients with dementia?

The findings from the study suggest virtual reality environments improve self-efficacy by providing a safe place, and realistic environment for practical nursing students to practice potential scenarios they may encounter when caring for clients with dementia. This paper has been written and formatted to adhere to the author guidelines for Clinical Simulation in Nursing.

4.0 Abstract

Background: Improving self-efficacy for nursing students to manage aggressive behaviours in clients with dementia supports better outcomes for clients. While a variety of educational strategies exist to attempt to accomplish the improvement, no studies have been conducted on the use of immersive virtual reality as a potential tool.

Method: This study used an explanatory sequential mixed-methods design to compare perceived self-efficacy for practical nursing students who used the CareGiVR™ virtual reality application with those who did not. The Inventory of Geriatric Nursing Self-Efficacy (IGNSE) measured changes in perceived self-efficacy pre and post-intervention along with qualitative focus groups.

Results: Forty-six students (49%) of a targeted study group, responded to the invitation to participate in the quantitative component. Fifteen students from the intervention group elected to participate in the follow-up qualitative focus groups. Findings indicate participants who used the CareGiVR™ application reported statistically significant higher levels of perceived self-efficacy post-intervention. Compared to the control group, participants who used the CareGiVR™ application had statistically significant higher levels of perceived self-efficacy following their clinical rotation. Based on the study data four themes were identified: getting real-world experience, a safe place to practice, meeting the client where they are at, and a tool not a replacement.

Conclusion: These findings suggest immersive virtual reality can be an effective tool to increase perceived self-efficacy for managing aggressive behaviours in clients with dementia in practical nursing students.

Keywords: virtual reality; nursing students; self-efficacy; dementia

4.1 Building Self-Efficacy in Dementia Care through Immersive Education: A Mixed Methods Study

The need for dementia education within nursing curricula has been well established, especially with the aging population (Alushi et al., 2015; Cariñanos-Ayala, 2022). However, Eccleston et al. (2015) identified students may lack knowledge around progression, symptoms, and management of the disease. This lack of knowledge suggests as students graduate, they may not have the necessary preparation to care for the increasing number of people with dementia (Eccleston et al., 2015). Long and Hale (2022) found nursing students often take a more conservative approach to managing aggressive behaviours and are more likely to ask for help or wait to intervene, an issue often attributed to low self-confidence, or lack of knowledge. Within the clinical setting, nurses are often required to make decisions quickly to support positive outcomes for clients. In their study Kimzey et al. (2019) discuss that experiential learning may improve knowledge and self-efficacy related to dementia care for older adults. One form of experiential learning which has become more utilized in nursing education is virtual reality (VR). However, the potential for this technology to increase self-efficacy for nursing students to manage aggressive behaviours in clients with dementia remains a gap in existing literature. Therefore, the purpose of this mixed-methods research project was to explore the effect of the CareGiVR™ virtual reality platform on student perceptions of self-efficacy in managing aggressive behaviours in clients with dementia.

4.2 Literature Review

4.2.1 Virtual Reality

Many definitions of virtual reality exist. Two variables are often considered: immersion and presence. Immersion represents the ways in which the user can interact within the virtual

space through various sensory stimuli (Kardong-Edgren et al., 2019). Presence refers to the extent to which the user experiences the simulated environment (Kardong-Edgren et al., 2019). Broad definitions of virtual reality are inclusive of equipment such as mobile devices, computer monitors, and head-mounted devices. Within this project, virtual reality has been defined as an immersive simulated experience where the user can interact within the three-dimensional, virtual environment, through multisensory modalities, using a head-mounted device and haptic technology.

4.2.2 Self-Efficacy

Self-efficacy was first proposed by Albert Bandura, it is the belief we have in our own abilities, specifically our ability to meet the challenges ahead of us, and complete a task successfully (Bandura, 1993). Increased self-efficacy has been linked to the reduction of caregiver and student stress (Tang & Chan, 2016). This stress affects not only caregivers but clients, employers, and the health system. Self-efficacy is anticipated to improve resiliency in caregivers leading to improved patient-caregiver interactions, enhanced continuity of care, and economic benefits for the healthcare system (Cuartero & Tur, 2021). Measurements of self-efficacy following dementia training have shown knowledge and self-efficacy were maintained after three months, but intervention skills showed decline (Mackenzie & Peragine, 2003).

4.3 Background

The CareGiVR™ project creates highly realistic immersive virtual reality (VR) scenarios, using unique virtual clients, who can demonstrate a thorough range of emotions produced through performance (motion & facial) capture. Nursing students can utilize the application to practice various responses and receive immediate feedback. While traditional lecture courses may only offer students the opportunity to receive information once, the

CareGiVR™ application allows the student to repeat the scenario as many times as they would like, for ongoing iterative learning. The use of immersive VR in within nursing programs has the potential to offer students more access to learning opportunities in a safe environment. Ideally, this increase in opportunities should result in greater self-efficacy, ultimately contributing to better outcomes for the client within the clinical practice setting.

The research questions for this study included:

(1) Does perceived self-efficacy improve for practical nursing students who use the CareGiVR™ application compared to those who do not, in relation to managing aggressive behaviors in clients with dementia?

(2) Are there significant differences between practical nursing students' perceived self-efficacy with managing aggressive behaviors in clients with dementia before and after using the CareGiVR™ application?

(3) How did practical nursing students perceive using the CareGiVR™ application influenced their self-efficacy with managing aggressive behaviours in clients with dementia?

4.4 Theoretical Framework

Project design and qualitative thematic analysis were guided by the analytic framework proposed by Risling and Risling (2020). Grounded in the principles of interpretive description, the framework uses key aspects of software design to guide the functional and non-functional features of technology for development teams (Risling & Risling, 2020). The framework is non-prescriptive; however, it facilitates extraction of data to support the design and refinement of a developing technology, in this case the CareGiVR™ platform. Use of the analytical framework is well-suited for studies where a proposed technology provides a solution to a clinical problem.

4.5 Methods

This study utilized a mixed-methods, explanatory design. Within the mixed-methods explanatory design the quantitative piece is followed by the qualitative (Creswell, 2014). The intent of the explanatory sequential design is for the quantitative data to provide a general understanding of the research question and the qualitative analysis to allow for a more in-depth exploration and understanding of the participant's views, providing critical context to the quantitative data (Bowen et al., 2017; Ivankov et al., 2006).

4.5.1 Sample

After institutional review board approval was received a purposive convenience sample of first year practical nursing (diploma) students enrolled at a mid-western Canadian college were recruited for this study (n=93). Students must have been enrolled in the clinical practice course which takes place in their second semester. Inclusion for this study was intentionally aimed at this group of students because they had previously received theoretical instruction about dementia within the same semester, however had not yet entered the clinical setting to care for this population. Recruitment was done by email invitation and the researcher attended the students' class to explain the project. Student participation in the study was voluntary, confidential from their instructor, and it was made known that the decision to participate would not affect their grades or course evaluation. The invitation email was circulated by an administrative assistant, therefore the researcher did not have access to the course roster.

4.6 Quantitative Phase

4.6.1 Quantitative Instrument

To measure changes in self-efficacy, the Inventory of Geriatric Nursing Self-Efficacy (IGNSE) was administered pre-intervention and post-intervention (Mackenzie & Peragine,

2003). The Inventory of Geriatric Nursing Self-Efficacy is a nine item Likert scale (Mackenzie & Peragine, 2003). This scale consists of nine items assessing self-perceptions of the degree of confidence one has in dealing with challenges experienced working on a dementia unit (Mackenzie & Peragine, 2003). There are three items for each of the following scales: teamwork, resident, and family challenges (Mackenzie & Peragine, 2003). For each item participants are asked to rate their confidence to remain calm, resolve the problem, and achieve a positive outcome. Each item is rated on a seven point Likert-type scale from "not at all confident" to "very confident" (Mackenzie & Peragine, 2003). The psychometric properties for the inventory include a Cronbach's alpha of 0.96 and average item–total correlation of 0.83 (Mackenzie & Peragine, 2003).

4.6.2 Data Collection Procedure

After providing informed consent each study participant completed the IGNSE via the Survey Monkey online survey platform and provided a contact email. Using the Microsoft Office Excel random number function, subjects were assigned to the control or intervention group. Because of time and scheduling constraints, this was done as an ongoing process in batches of six to ten students. At the end of recruitment, both the intervention and control groups had 20 students.

4.6.2.1 Intervention Group

Each student scheduled an individual appointment in the virtual reality lab located within the educational institution. During the appointment the researcher met the students and provided an orientation to the Oculus Quest 1 VR headset, Oculus Touch controller equipment operation, and an overview of the scenario. The use of the CaregiVR^{TM} application did not require the participant to enter any login credential or enter any personal information into the application or

computer. No personal data was collected or stored when the participant completed the CaregiVR™ scenario using the Oculus Quest 1 headset.

Once the application was launched a visual tutorial of how to move within the virtual space, pick up objects, and interact with the client took place. After the tutorial the participants worked through the 'Vivian' dementia case scenario. During this time the researcher was present ensuring safety of the participant from cords, and walls, and observed for signs of disorientation or distress. The researcher was able to watch the same view as the participant through a computer monitor and observe their clinical decisions within the scenario. The researcher would answer operational questions from the participant, if necessary. Following the conclusion of the scenario a user report of every participant was automatically generated by the software detailing the participant's activity log, including the decision, time, repetition, and total progress through the scenario.

Immediately after the scenario the participant was taken into an adjacent room to complete the IGNSE a second time without the researcher present. The student provided email from the initial survey was re-entered to be able to pair responses. Participants were also advised they would receive the survey a third time, and a focus group invitation after their clinical course was completed. Once the appointment concluded all equipment was sanitized according to institutional policies and reset. Appointments were not booked back-to-back to allow the student time to exit the lab and protect their confidentiality. Implementation of the intervention did not result in any delays or malfunctions with the technology. In one instance, the system had to be restarted prior to the participant commencing the scenario.

4.6.2.2 Control Group

Members assigned to the control group were notified via an email. Participants were

advised they would be receiving a second invitation to complete the IGNSE once their clinical course was completed. Once data collection closed, anyone who wished to participate in the 'Vivian' scenario was given an opportunity via an email invitation. No students from the control group elected to participate.

4.6.3 Analysis

Data were collected via the web-based survey tool Survey Money and exported to a Microsoft Excel spreadsheet. All data analysis were performed using Statistical Package for the Social Sciences (SPSS) version 28. When necessary, consultation with a statistical tutor was done through the researcher's institution.

4.7 Results

46 students total (49%) of the targeted participant group responded to the invitation to participate. After reviewing the raw data two surveys were not completed and therefore removed prior to randomization. Initially, there were (n=22) students assigned to both the control and intervention group. Two students from the intervention group did not make appointments to participate in the scenario and therefore their responses were excluded. An additional two intervention group students and six control group students did not complete the post-clinical survey and their data was excluded from question 1. Analysis of questions 1 and 2 were completed independent of each other.

Question (1): Does perceived self-efficacy improve for practical nursing students who use the CareGiVR^{TM} application compared to those who do not, in relation to managing aggressive behaviors in clients with dementia?

Normality testing demonstrated the control (n=20) and intervention (n=20) groups pre-clinical mean scores for the IGNSE to be normally distributed. Control group (Shapiro-Wilk

p=0.604; Kolmogorov-Smirnov p=0.200). Intervention group (Shapiro-Wilk p=0.946; Kolmogorov-Smirnov p=0.200). Shapiro-Wilk test for normality is regarded as more appropriate for smaller sample sizes <50 (Mishra et al., 2019). Levine's Test for Equality of Variances was not significant (p=0.137) therefore, equality of variances is assumed. Mean intervention group post-clinical scores were significantly higher than the control group (p=0.003). The mean score post-clinical for the intervention group was 53.3 (SD=6). The mean score post-clinical for the control group was 43.8 (SD=10.7). Table 4.1 summarizes these findings.

Table 4.1 Summary of mean IGNSE scores between control and intervention groups

	Intervention (n=18)	Control (n=16)	Sig.
Pre-Clinical	34.1	43.3	
Post-Clinical	53.3	43.8	p=0.003

Mean control group post-clinical scores were not significantly higher than pre-clinical (baseline) scores (p=0.840). Mean intervention group post-clinical scores were significantly higher than pre-clinical (baseline) scores (p<0.000). Students had a mean pre-clinical (baseline) score of 34.1 (SD=7.7), whereas the mean post-clinical score was 53.3 (SD=6.0). Therefore, the null hypothesis of no differences for practical nursing students who use the CareGiVR™ application compared to those who do not, in relation to managing aggressive behaviors in clients with dementia is rejected. Table 4.2 summarizes these findings.

Table 4.2 Summary of mean IGNSE scores within control and intervention groups

	Intervention (n=18)	Control (n=16)
Pre-Clinical	34.1	43.3
Post-Clinical	53.3	43.8
Sig.	p < 0.01	p=0.840

Question (2): Are there significant differences between practical nursing students'

perceived self-efficacy with managing aggressive behaviors in clients with dementia before and after using the CareGiVR™ application?

Normality testing demonstrated the student pre-intervention post-intervention differences to be normally distributed (Shapiro-Wilk p=0.943; Kolmogorov-Smirnov p=0.200). Mean student post-intervention scores were significantly higher than student pre-intervention scores ($p<0.000$). Students had a mean pre-intervention score of 35.8 (SD=8.9), whereas the mean post-intervention score was 49 (SD=6.6). Cohen's effect size value ($d = .76$) suggests a moderate to high practical significance. Therefore, the null hypothesis of no differences between practical nursing students' perceived self-efficacy with managing aggressive behaviors in clients with dementia before and after using the CareGiVR™ application is rejected.

Table 4.3 Summary of mean IGNSE scores within intervention group pre-intervention and post-intervention

(n=20)*	Mean IGNSE Score	Sig.
Pre-intervention	35.8	
Post-intervention	49	$p < 0.01$

*Analysis included two students who did not complete the post-clinical survey

4.8 Qualitative Phase

4.8.1 Procedure

Informed by the quantitative findings, CaregiVR™ user reports, and researcher field notes, a structured focus group interview guide was developed. Questions were drafted by the principal investigator and were reviewed and refined by several members of the research team until consensus was reached. Each participant from the intervention group was contacted via email and invited to participate in a focus group. Focus groups were not held until after the students received confirmation of their final grade in the course. If none of the scheduled times

worked participants were offered the option to select an alternate time, however no subjects utilized this option. In total, three focus groups were held with an average group size of four to six and 15 participants total, excluding the researcher.

Focus groups were held in a private password protected Zoom room and lasted approximately 45min each. Each session was recorded for audio and video to allow for analysis of dialogue and non-verbal behaviours. The sessions were transcribed using the caption feature and reviewed against the audio for confirmation. At the beginning of each focus group session participants were reminded to maintain confidentiality within the group and advised the session was being recorded. Participants were free to withdraw from the focus group session at anytime, and advised to log out of the session if they did not wish to continue.

4.8.2 Data Analysis

The qualitative phase of this explanatory study was guided by an interpretive description approach as described by Thorne (2016). Data analysis began following the first focus group in a constant comparative format and continued until all focus groups were completed. The researcher became immersed in the data by reading transcripts, listening to recorded audio, and reflecting on observations and field notes. Thorne et al. (2004) cautions against early line-by-line coding which may force themes and instead suggests the researcher maintain a broader lens and ask reflective questions such as “what is happening here?”

4.9 Results

Three focus groups were conducted over the span of two weeks. In total, fifteen students from the intervention group elected to participate. Based on the study data four themes were identified: getting real-world experience, a safe place to practice, meeting the client where they are at, and a tool not a replacement.

4.9.1 Getting real-world experience

When asked to reflect on the experience of using the CareGiVR^{TM} application, study participants from the intervention group noted the application was a way to gain potentially real-world experience through the use of VR. This finding meant the students were able to experience a potential scenario they may encounter within the clinical setting and experiment with a variety of interventions. One participant, SN3, noted how the scenario presented was similar to an event which occurred within the clinical setting:

> "It's funny when [client] became upset with me I thought back about Vivian and it was like 'ok I know what to do I have seen this before' so ya, it made me feel like I could handle this you know? It made me feel like I could do what I did with Vivian because I had tried it with her and it worked. I didn't have to immediately call for help"

Within the focus group the students discussed the perceived fidelity of the scenario. A participant recalled their time within the VR application and noted the realism of the scenario helped contribute to feeling as though the scenario was actually occurring rather than taking place in a lab. SN6 explains:

> "When you put the headset on, I dunno it's like I forgot where I was. I think that's what made me get so into it. Like I really cared about her and what was going on. When she was getting upset at me I could feel myself getting more and more frustrated. It's like I forgot I was in the simulation and I really was in a long-term care room trying to get this client ready. Even the drawings and the lamp, like it was so realistic."

4.9.2 A Safe Place to Practice

During the focus groups a common theme was the concept of safety. Participants reinforced the advantage of the CareGiVR™ platform allowing for practice without risk of injury to self or client. Students noted that although the avatar 'Vivian' would often display non-verbal body language suggesting she may strike out or kick, the students were aware there was no risk of physical harm. As SN12 explains:

> "At one point she didn't like the hairbrush I gave her and she like almost threw it at me and shouted. I jumped because I wasn't expecting it but like that could happen you know? So like, you need to be prepared and I knew I couldn't get hurt. So I kept going and trying the scenario and I eventually was able to brush her hair. I don't know what I would have done if that was real clinical and she actually threw it at me, I probably would have needed help but in the scenario I knew she couldn't hurt me and she's not real so like she wasn't going to get hurt either, so I could keep practicing.'

The theme of practicing in a safe place also emerged within the context of assessment and self-perception. Students appeared to associate their own psychological safety with the scenario being non-evaluative and individual. SN4 described their experience:

> "There wasn't any risk you know? It's not like this was a lab exam that my instructor was going to fail me and I'd get kicked out if I did something wrong, or embarrass me in front of everyone in the class, since no one else was here and you already said this was for learning and you wouldn't tell if we did something bad." The idea of not being singled out or having others peers aware of the outcome of

the scenario was reinforced by SN3.

> "I would have never done this if people were watching me like in a demo in class. But no one else was even around so I didn't really feel like I had anything to lose – I'm competitive so I wanted to win but I knew nothing bad was going to happen so I figured I may as well try to give her that flipping hairbrush on more time and it worked! *laughs*"

4.9.3 Meeting the Client Where They Are At

Students acknowledged during the CareGiVR™ scenario there were times they experienced feelings of frustration and annoyance because the client would not comply with the intervention. SN2 recalled a situation where she had to use a facecloth to help wash Vivian's face:

> "Like I could feel myself getting tense and annoyed and I had to be like 'ok stay calm this isn't anyone's fault she has dementia' but it was hard you know? I wanted her to just let me do it but I knew I had to try something else since it wasn't working. But that's the thing like it isn't their fault and it isn't yours either when something doesn't work you can't overthink it you just need to meet them where they are at and do the best you can."

One student, SN4, recalled their experience within the CareGiVR™ platform and explained how the scenario contributed to their reflective practice:

> "It was cool because you are kind of on this ride into this person's life and what they go through everyday. Like you kind of forget in clinical that some of them have been living there for years and we just drop in and they have to deal with us as much as we have to deal with them, well you know what I mean,

like I bet that's annoying seeing someone new everyday who doesn't know what you like. I think we as nurses need to kind of cut them some slack when this happens."

The literature review on the use of immersive virtual reality with students noted the capacity for this technology to assist in building empathy with students (Ma et al., 2021; Saab et al., 2022). Although the students in this study did not explicitly use the term empathy the description of 'meeting the client where they are at supports' this idea. SN10 acknowledges the concept of empathy as a determining factor for their own self-efficacy.

"I didn't really think about it at the time but after I was like, man it must be really tough to not be able to do stuff anymore, like for her especially since she used to do everything. So you can kind of see why she would get so frustrated with us always bugging her, especially if she's confused. Like that was my big thing for clinical I think is just like that we really don't know when they will have good days or bad days but I know that I can still do a good job and try to help them as much as I can because they aren't doing it on purpose."

4.9.4 A Tool not a Replacement

During the interview, students were asked to envision how CareGiVR™ and virtual reality could be used within the program as way to build self-efficacy in dementia education. Students were enthusiastic about the prospect of this technology being integrated into the curriculum. However, students also expressed while they felt the technology would be useful it could not fully replace the clinical setting as a learning tool. SN4 expressed:

"I think it has its place for sure, like I could see us using it to practice in the lab before

clinical but I still think we need real experiences. Especially for the hands-on stuff like you still are holding controllers with the VR and you have a limited amount of options and things you can do. Plus there was only one head set so I don't really know how that would work unless you had more."

The importance of clinical learning and the protection of these hours was emphasized by one student SN6 who explained:

"Don't get me wrong I am super super glad I did this, it was awesome. But I still think I am going to learn the most in clinical. I'd almost want to do this more during lab time than have it be for clinical. Like you could pull us out individually and let us run through the scenario and learn how to do it and whatnot but I still like we need to go to clinical to work with clients."

One student offered specific insight as to how they would suggest the CareGiVR™ platform be utilized within the program as a way to build self-efficacy in dementia education

"So if I were you I'd do it as like an extra because for one thing it wouldn't really work to have us all there at once like we are when we are together at clinical. I could see it being maybe an optional thing for students who are really nervous about clinical or in the lab to go and use it but there are still parts that aren't real – like the teleport part you can't do in clinical and you only have a few options to pick from with this, in clinical anything can happen and you need to know what to do, so like this helps but it's not going to totally prepare us."

4.10 Discussion

Overall, the practical nursing students were enthusiastic about the potential for the CareGiVR™ application to be utilized as an educational tool within their program to improve

self-efficacy when caring for clients with dementia. Students felt that the scenario provided an element of realism not offered in the traditional laboratory setting. The scenario evoked the same emotions one may feel during clinical practice if a client is being aggressive and non-compliant, including frustration and annoyance. The result of experiencing these emotions allowed the students to reflect on their own behaviours and body language during the scenario, and recognize the importance of self-regulation and understanding the disease process. By meeting the client where they were at cognitively, and recognizing the actions taken by the avatar were part of the disease process, rather than a personal attack, the students felt better equipped to anticipate how they would respond in a real-word setting. Additionally, students highlighted the importance of being able to practice in a safe setting, where although the avatar was displaying a variety of facial and physical movements suggesting they may exhibit an aggressive response, the students were aware there was no risk of injury to themselves or a client.

The practical nursing students highlight the importance of integrating the CareGiVR™ application the enhance experiences, not replace clinical hours. Utilizing these findings allows the research team to anticipate ways to recommend the integration of the CareGiVR™ application to nursing curriculum and demonstrates the positive impact the CareGiVR™ application has on improving self-efficacy for nursing students.

4.10.1 Recruitment Limitations

Participants were recruited from one college in mid-western Canada and therefore their experiences are specific to their program. One noted limitation is the attrition within the post-clinical control and intervention groups, which limited the sample size for the comparison. Timing of the study may have negatively impacted recruitment and contributed to the small sample size because students were also preparing for final exams during the quantitative survey

and on semester break during the focus group recruitment. The mean scores of the initial data had difference of (9.2) which may suggest group variances despite a randomization protocol. De Boer et al. (2015) advise baseline data in control and intervention comparison groups should not be analyzed for statistically significant differences because the report will detail the randomization protocol and statistical testing will not provide additional information to validate the protocol.

4.10.2 Implications for Future Research

The qualitative findings from the study suggest virtual reality environments improve self-efficacy by providing a safe, realistic environment for students to practice potential scenarios they may encounter when caring for clients with dementia. However, students expressed they did not feel VR could become a full substitute for clinical experiences and would best function as an addition to their curriculum not a replacement. Future research opportunities could include further longitudinal studies to assess if the self-efficacy scores reported in the IGNSE were maintained long-term and considering larger sample sizes with inclusion of baccalaureate nursing students.

4.11 Conclusion

Data within this study demonstrates that immersive virtual reality led to an increased self-efficacy within an intervention group of practical nursing students preparing to manage possible aggressive behaviours in clients with dementia. There was a statistically significant increase in the mean score of the IGNSE scale within the intervention group after using the CareGiVR^{TM} application. Compared to the control group, the intervention group had a statistically higher perceived self-efficacy to manage aggressive behaviours in clients with dementia after their clinical practice course. Building on existing knowledge that virtual reality can be an effective

learning tool for nursing students, this study suggests simulated aggressive dementia clients have the potential to support an increased self-efficacy among their future care providers. Future research should include larger samples, and diverse nursing student populations.

4.12 Funding

Funding for this project was provided thorough an Alberta Innovates research grant.

4.13 REB Approval

REB Approval for human ethics was obtained through the University of Saskatchewan and Lethbridge College.

4.14 Conflict of Interest

The author has no conflict of interest to declare.

4.15 Chapter Summary

The findings from this study contribute to an increased understanding of how the CareGiVR™ immersive virtual reality application influences perceived self-efficacy for practical nursing students to manage aggressive behaviors in clients with dementia. There was a significant difference between practical nursing students' perceived self-efficacy with managing aggressive behaviors in clients with dementia before and after using the CareGiVR™ application and between the control and intervention groups. Four themes were identified during the qualitative analysis: Getting real-world experience; a safe place to practice; meeting the client where they are at; and a tool not a replacement. This chapter highlights the need for ongoing research to include broader populations of nursing students and whether the IGNSE self-efficacy scores reported were maintained long-term.

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CHAPTER 5

The purpose of this study was to explore the effect of the CareGiVR™ immersive virtual reality platform on student perceptions of self-efficacy in managing aggressive behaviours in clients with dementia. The research questions which guided the inquiry were:

(1) Does perceived self-efficacy improve for practical nursing students who use the CareGiVR™ application compared to those who do not, in relation to managing aggressive behaviors in clients with dementia?

(2) Are there significant differences between practical nursing students' perceived self-efficacy with managing aggressive behaviors in clients with dementia before and after using the CareGiVR™ application?

(3) How did practical nursing students perceive using the CareGiVR™ application influenced their self-efficacy with managing aggressive behaviours in clients with dementia?

This final chapter, will integrate the results of the research in Chapter Four into implications for practice, research, and education within the broader context of the existing knowledge discussed in Chapter Two. The three manuscripts included in this dissertation reflect the research process in the following manner: Manuscript one (Chapter Two) presented a scoping review with the purpose of understanding the way immersive virtual reality is being utilized within nursing education and identifying a knowledge gap, which ultimately informed the research questions for the study. Manuscript two (Chapter Three) focused on the application of the user-centered design theoretical framework and provided an overview of the CareGiVR™ project along with the study design and methodological considerations. Manuscript three (Chapter Four) addressed the quantitative and qualitative results from the study and future research implications.

5.0 Discussion

From the study, within the population of practical nursing students, it is apparent their self-efficacy improved following using the CareGiVR™ application, and their perceived self-efficacy was higher than that of their peers who did not use the CareGiVR™ application, following their clinical practice experiences. When students have a higher self-efficacy they may perform better in the clinical setting, exhibit higher levels of independence, and be less likely to leave the program (Alosaimi, 2021; Gregory et al., 2022). Four themes were identified during the qualitative analysis within this study: getting real-world experience, a safe place to practice, meeting the client where they are at, and a tool not a replacement. Similar to previous studies (Adhikari et al., 2021; Siah et al., 2022) these findings suggest students regard the use of immersive virtual reality as having a positive impact on student learning. Only a couple of studies have included a control group to measure the comparison (Butt et al., 2018; Chao et al., 2021). The use of a control group can help demonstrate the difference in IGNSE scores was related to the CareGiVR™ intervention, rather than coincidental. None of the previous research included the use of immersive virtual reality to improve practical nursing students' self-efficacy to manage aggressive behaviours in clients with dementia. Therefore, this study helps to fill a gap within the existing body of nursing knowledge and create future opportunities for ongoing research in this area.

In addition to discovering the improved perceived self-efficacy for nursing students who used the CareGiVR™ application, this study interpreted the experiences of using the application from the perspective of the participants. In doing so, it became evident the students regard the CareGiVR™ application positively and feel it could provide a meaningful learning experience within their program. Furthermore, this study represented the student population whose

perspective may not always be considered when making pedagogical decisions for nursing program curriculum development. While the use of virtual reality within programs is positively regarded by students, this group felt it would not be able to fully replace the clinical practice experience, and should instead be an additional teaching tool, not a replacement. These findings provide insight into students' perceptions of the CareGiVR™ virtual reality program and may provide guidance to nursing educators for effective integration of virtual reality as a teaching tool.

5.1 Implications for Practice

This study affirms virtual reality can be an effective strategy for building self-efficacy to manage aggressive behaviours in clients with dementia. As demonstrated in this research, perceived self-efficacy for managing aggressive behaviours in clients with dementia can increase when students utilize the CareGiVR™ application compared with those who do not. For healthcare administrators, it is important to be aware of the educational teaching approaches potential employees have utilized within their nursing programs to learn strategies for managing aggressive behaviours in clients with dementia, and advocate for the mindful integration of VR into education as a teaching strategy. This will support a future workforce who are well-equipped to meet the needs of dementia clients.

Despite the growing interest in virtual reality as a strategy for education and professional development, the use of VR for dementia care education is largely unexplored. To use this technology to it's full potential for caregivers of clients with dementia, facilitating access is key. There are funding agencies across Canada seeking to explore and integrate the use of virtual reality into educational programs both for students and professionals (e.g. Alberta Innovates, The Alzheimer Society of Canada, Grand Challenges Canada). Health care administrators must

acquire an increased awareness of these programs and seek partnerships with stakeholder organizations to ensure funding is allocated where health care professionals identify the greatest need. This may include creating opportunities for professional development and collaboration for caregivers to engage in the technology design process.

5.2 Implications for Research

Previous research and the results of this study demonstrate that VR can be a viable teaching tool within nursing education. The CareGiVR™ application tested one scenario with students. As newer versions of the application become available and additional scenarios are developed, ongoing evaluation of the effectiveness of the software will be necessary. Guided by the user-centered design framework proposed by Risling and Risling (2020) the software evaluation should include not only the technical aspects but also how it is integrated within existing processes, and whether there are any unintended consequences or complications. Within this study the dependent variable was self-efficacy. Future studies could measure other positive traits such as resilience, determination, empathy, and competence.

Within the study, the population was first year practical nursing students at one mid-western college in Canada. Future research could include students and registered professionals from a variety of health disciplines. Within this study, the final survey took place within ten days of the clinical experience concluding. Longitudinal studies which follow the students throughout the duration of their program to determine if scores are maintained would be valuable to learn if using CareGiVR™ application helps to maintain self-efficacy over the long term.

Along with health care workers an estimated 1.4 billion hours of care received by persons living with dementia will be provided by informal care partners such as spouses and children by the year 2050 in Canada (Alzheimer Society of Canada, 2022). With the knowledge gained from

this study, the CareGiVR™ application should also be tested with informal caregivers to see if the increases to self-efficacy are similar, and if not, what adaptations to the platform are necessary to support this population.

5.3 Implications for Education

This study is the first of its kind exploring the use of virtual reality for improving self-efficacy in managing aggressive behaviours in clients with dementia with a practical nursing student population. The findings from this study contribute to a broader body of knowledge for future nursing education in this area. Findings from this study suggest practical nursing students who utilized the CareGiVR™ application had significantly greater perceived self-efficacy compared to their baseline scores and that of their peers who did not use the application. Through focus group interviews the themes: getting real-world experience, a safe place to practice, meeting the client where they are at, and a tool not a replacement emerged.

Nursing education programs could incorporate the CareGiVR™ application into their curriculums prior to having students enter the clinical practice setting. Because students felt the VR application served as a tool and not a replacement for the clinical practice setting, educators can utilize that information to guide pedagogical decision making. Although the CareGiVR™ application may never fully replace students' clinical practice experiences, it can provide an opportunity for levelling of course outcomes to ensure all students have an opportunity to apply the theoretical principles of management of aggressive behaviours, which is not always guaranteed within the unpredictable clinical setting. Students expressed they felt the application provided a safe place for them to practice by nature of the application allowing opportunity for repeatability and being non-evaluative, therefore, rather than using the VR application for summative evaluation, nursing educators should consider the integration of technology for

formative assessment. The nursing educator may consider the CareGiVR™ application as a remediation strategy whereby students could have ongoing practice.

Because the technology is limited to being used by one student at a time, nursing educators will want to consider having multiple headsets available to maximize student access within their courses and access to the necessary supplies for cleaning. Within the existing literature it was suggested that students responded more positively to the virtual reality when they had adequate orientation and familiarly with the technology (Saab et al., 2020; Siah et al., 2022). Therefore, when planning to integrate the CareGiVR™ application into their curriculum, nursing educators should be mindful to intentionally schedule orientations for showing students how to use the use the controllers and interact with the features of the application, while allowing time for questions and clarification.

5.4 Strengths and Limitations

In this research, the sample size for the quantitative intervention was thirty-four for the between-groups analysis, and twenty within the control group. Although this sample was large enough to produce a significant result and reject the null hypothesis the study would be strengthened by a larger sample size to detect a smaller effect size and produce greater statistical power within the study. Within the design of the study recruitment had to occur after the theoretical instruction on aggressive behavior management for clients with dementia, but prior to the student entering the practice setting. During this timeframe students were also completing their laboratory examinations and practical skills testing. Therefore, the recruitment may have been impacted by students prioritizing their assessments over voluntary participation in the study.

The smaller size of the focus groups may be perceived as a limitation within this study.

However, within interpretive description Thorne (2016) suggests any sample size may be appropriate so long as it generates findings which merit answering the research question. The sample population from this study included practical nursing students from only one post-secondary institution. Therefore, generalization of these findings to the broader nursing student populations should be done with caution.

The COVID-19 pandemic was a major limitation of this study. Due to institutional policies limiting the ability for students to be present on campus, data collection was delayed for a year from March 2021 to March 2022, until the restrictions allowing students to be present on campus were lifted. A renewal of the ethics certificate was sought and granted to allow for the extended time frame. Because of this delay, initial enthusiasm for the project may have waned, as anecdotally many members of the post-secondary community were aware of the CareGiVR™ project by nature of the size of the grant awarded to the institution. During the time frame for data collection the requirement to mask was optional and students were permitted to be on campus. Despite this, there may have been hesitancy from the student population to participate, knowing this would warrant additional time in the presence of another person. Although all institutional and provincial guidelines were followed to clean and social distance, participation carried increased risk of exposure to the COVID-19 virus. This increased risk may have impacted the response rate to the survey and overall participation in the study.

Prior to the COVID-19 pandemic the original research design included having the focus-groups in person. Switching to an online Zoom platform may have presented both a strength and limitation. The ability to record the sessions allowed the researcher the ability to view the recorded video and note the body language and responses as much as necessary, rather than relying only on audio recordings. However, the switch to an online platform for the focus groups

also may have limited the richness of the data by not having everyone in the same room to establish rapport and facilitate the discussion.

5.5 Researcher Reflections

The methodology of ID acknowledges the researcher will have their own disciplinary knowledge and experience, often this is where the enthusiasm for the initial research comes from (Thorne, 2016). While some forms of qualitative research expect the researcher will bracket their preconceptions to mitigate potential bias and interpret the data with an open mind, Thorne (2016) suggests instead the researcher should recognize how their disciplinary orientation can be foundational to the study design and guide decision making. As a nursing educator, administrator, and registered nurse for more than a decade I have worked both providing care for persons living with dementia as well as provided clinical and theoretical instruction for nursing students. Having these lived experiences helped me to recognize the need for this research and make pragmatic decisions for how to design a study with this specific student population.

When the initial design of the CareGiVR™ project began I was employed by the institution where the students attended, however I was not actively employed during the time of data collection. Having working knowledge of the students' curriculum and the disciplinary knowledge of nurses' roles within the facilities students attended for their clinical practice experiences I think was an advantage for the qualitative data collection. When students would refer to specific elements of the course curriculum and use nursing jargon I did not have to pause the conversation for clarification. Instead, the conversation was able to continue into greater depth because I was familiar with their experiences, ultimately producing a more meaningful narrative.

The research team for the CareGiVR™ project was inter-disciplinary within the health

sciences and computer science. Working with a variety of professions was a fulfilling experience and increased my appreciation for the value other health disciplines can bring to the care of clients living with dementia. For example, the members of the team who are recreation therapists offered a different lens to the scenario development than the nursing members. Guided by the Risling and Risling (2020) user-centered design framework the software developers and VR programmers were able to bring our ideas to fruition and establish the functional and non-functional requirements of the application.

During the data collection and analytic process I kept a journal of anecdotal field notes of my reflections and observations during the CareGiVR™ simulation and focus groups. These notes included observations of body language, emotional reactions, and my own internal thoughts. Because the study design was sequential, the time between the initial student appointments to participate in the CareGiVR™ simulation and the final focus group was approximately two months. Having the field notes to look back on provided me an audit trail of my thoughts and observations to help inform my analysis.

5.5.1 Research During the COVID-19 Pandemic

The COVID-19 pandemic presented many challenges to my research study, however there were also silver-linings and opportunities for personal and professional growth. When the study was originally conceptualized there was no indication that a global pandemic would result in the cancellation of classes in the following months. Although the result of this caused initial frustration that data collection would have to be delayed for a year this offered the research team the gift of time. We were able to further refine the scenario to increase the fidelity, and work through any technical challenges. Initially, the study design required a member of the virtual reality faculty to be present to set up the technology and provide the student orientation to the

hardware. Since the project was delayed I was able to develop my own competency to navigate the technology and by the time data collection occurred, I was able to do this on my own without difficulty.

As a novice researcher, I had more time to review methodological and disciplinary studies to further develop my knowledge. Although at times the process was cumbersome to navigate, including the changing provincial guidelines for masking and isolation. However, this new complexity provided me an unexpected opportunity to work with members of the institutional occupational health and safety committee and gain experience with completing hazard assessments. Although I consider myself competent with online communication platforms such as Zoom, the facilitation of an online focus group offered me the opportunity to explore and use more features such as the live transcript and privacy features which hopefully will be useful in future studies.

5.5.2 Data Confidentiality in a Digital Age

As a self-proclaimed 'millennial' I often joke with my peers that I have completed the majority of my graduate education without owning a printer. Even prior to the COVID-19 pandemic, and the requirement to be fully online, I worked almost exclusively paperless. I relied on my shared drives for document storage and data management, some of which I pay out of pocket to a private company for. While this provides a clean workspace and the ability to access files anywhere, it created challenges with data confidentiality and storage for this project. Data collected and stored using cloud services (Google Dropbox, iCloud, etc.) are susceptible to breaches and hacks. During this project, I had to be mindful of the risks to confidentiality of the participant data while using the CareGiVR^{TM} application. The research was conduced with the headset wired directly into the desktop computer and did not require internet access or an

individual login to run. No data was stored on the cloud, instead it was stored directly onto my password protected hard drive. I believe this will be an ongoing challenge researchers will need to be mindful of. It may be likely future research teams will need to include computer science experts with the knowledge of how to safeguard against potential data breaches and an understanding of the implications of how big data and cloud storage can threaten the confidentiality of collecting participant data.

5.6 Concluding Thoughts

This research was the first to use a mixed methods interpretive descriptive approach in exploring the use of the CareGiVR™ virtual reality platform on student perceptions of self-efficacy in managing aggressive behaviors in clients with dementia. The findings from this study address a knowledge gap and provide recommendations for future research with varied populations and outcome measures. For nursing educators, the use of virtual reality may provide an effective way to improve self-efficacy for students before they enter the clinical practice setting to care for clients living with dementia who may potentially display aggressive behaviors. Ultimately, dementia is on the rise and the students of today will be part of the future workforce tasked with managing the resultant care needs of this population. Students who have a higher perception of their own self-efficacy in providing this kind of specialized care, may have less workplace stress and contribute to better outcomes for clients and a more positive work environment overall.

5.7 References

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Appendix A

UNIVERSITY OF SASKATCHEWAN

Behavioural Research Ethics Board (Beh-REB) 29-Mar-2021

Certificate of Approval

Application ID: 2601

Principal Investigator: Tracie Risling Department: College of Nursing

Locations Where Research Activities are Conducted: Lethbridge College 3000 College Dr S Lethbridge AB, Canada

Student(s): Laura Vogelsang

Funder(s): Alberta Innovates

Sponsor: Alberta Innovates

Title: CareGiVR: Building Self-Efficacy in Dementia Care Through Immersive Education

Approved On: 29-Mar-2021

Expiry Date: 29-Mar-2022

Approval Of: Application for Institutional Ethics (Lethbridge College)

Participant Consent Form - Group Interview

Informed Consent Form

Letter of Invitation

Hazard Assessment Worksheet

Survey Questions

Acknowledgment Of:

Review Type: Delegated Review

CERTIFICATION

The University of Saskatchewan Behavioural Research Ethics Board (Beh-REB) is constituted and operates in accordance with the current version of the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans (TPCS 2 2018). The University of Saskatchewan Behavioural Research Ethics Board has reviewed the above-named project. The proposal was found to be acceptable on ethical grounds. The principal investigator has the responsibility for any other administrative or regulatory approvals that may pertain to this project, and for ensuring that the authorized project is carried out according to the conditions outlined in the original protocol submitted for ethics review. This Certificate of Approval is valid for the above time period provided there is no change in experimental protocol or consent process or documents.

Any significant changes to your proposed method, or your consent and recruitment procedures should be reported to the Chair for Research Ethics Board consideration in advance of its implementation.

ONGOING REVIEW REQUIREMENTS

In order to receive annual renewal, a status report must be submitted to the REB Chair for Board consideration within one month prior to the current expiry date each year the project remains open, and upon project completion. Please refer to the following website for further instructions: https://vpresearch.usask.ca/researchers/forms.php.

Digitally Approved by Diane Martz, Chair, Behavioural Research Ethics Board
University of Saskatchewan

1 / 1

UNIVERSITY OF SASKATCHEWAN

Behavioural Research Ethics Board (Beh-REB) 29-Mar-2022

Certificate of Re-Approval

Application ID: 2601

Principal Investigator: Tracie Risling Department: College of Nursing

Locations Where Research Activities are Conducted: Lethbridge College 3000 College Dr S Lethbridge AB, Canada

Student(s): Laura Vogelsang

Funder(s): Alberta Innovates

Sponsor: Alberta Innovates

Title: CareGiVR: Building Self-Efficacy in Dementia Care Through Immersive Education

Approval Effective Date: 29-Mar-2022

Expiry Date: 29-Mar-2023

Acknowledgment Of: N/A

Review Type: Delegated Review

* This study, inclusive of all previously approved documents, has been re-approved until the expiry date noted above

CERTIFICATION

The University of Saskatchewan Behavioural Research Ethics Board (Beh-REB) is constituted and operates in accordance with the current version of the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans (TCPS 2 2014). The University of Saskatchewan Behavioural Research Ethics Board has reviewed the above-named project. The proposal was found to be acceptable on ethical grounds. The principal investigator has the responsibility for any other administrative or regulatory approvals that may pertain to this project, and for ensuring that the authorized project is carried out according to the conditions outlined in the original protocol submitted for ethics review. This Certificate of Approval is valid for the above time period provided there is no change in experimental protocol or consent process or documents.

ONGOING REVIEW REQUIREMENTS

In order to receive annual renewal, a status report must be submitted to the REB Chair for Board consideration within one month prior to the current expiry date each year the project remains open, and upon project completion. Please refer to the following website for further instructions: https://vpresearch.usask.ca/researchers/forms.php.

Digitally Approved on behalf of the Chair
Behavioural Research Ethics Board
University of Saskatchewan

UNIVERSITY OF SASKATCHEWAN

Certificate of Approval Amendment

Application ID: 2601

Principal Investigator: Tracie Risling Department: College of Nursing

Locations Where Research Activities are Conducted: Lethbridge College 3000 College Dr S Lethbridge AB, Canada

Student(s): Laura Vogelsang

Funder(s): Alberta Innovates

Sponsor: Alberta Innovates

Title: CareGiVR: Building Self-Efficacy in Dementia Care Through Immersive Education

Approved On: 14-May-2022

Expiry Date: 29-Mar-2023

Approval Of: Behavioural Amendment Form: 10-May-2022

Focus Group interview guide questions

Acknowledgment Of:

Review Type: Delegated Review

CERTIFICATION

The University of Saskatchewan Behavioural Research Ethics Board (Beh-REB) is constituted and operates in accordance with the current version of the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans (TPCS 2 2018). The University of Saskatchewan Behavioural Research Ethics Board has reviewed the above-named project. The proposal was found to be acceptable on ethical grounds. The principal investigator has the responsibility for any other administrative or regulatory approvals that may pertain to this project, and for ensuring that the authorized project is carried out according to the conditions outlined in the original protocol submitted for ethics review. This Certificate of Approval is valid for the above time period provided there is no change in experimental protocol or consent process or documents.

Any significant changes to your proposed method, or your consent and recruitment procedures should be reported to the Chair for Research Ethics Board consideration in advance of its implementation.

ONGOING REVIEW REQUIREMENTS

In order to receive annual renewal, a status report must be submitted to the REB Chair for Board consideration within one month prior to the current expiry date each year the project remains open, and upon project completion. Please refer to the following website for further instructions: https://vpresearch.usask.ca/researchers/forms.php.

Digitally Approved by Pammla Petrucka
Chair, Behavioural Research Ethics Board
University of Saskatchewan

Appendix B

Research Ethics Board
ph. 403.320.3202 ext. 5787• Fax. 1-888-858-8517
3000 College Drive South • Lethbridge, AB T1K 1L6
appliedresearch@lethbridgecollege.ca
www.lethbridgecollege.ca

Date: March 2, 2021

Protocol Number:	LC-21-08
Principal Investigator:	Laura Vogelsang
Project Title:	CareGiVR: Building Self-Efficacy in Dementia Care Through Immersive Education

Thank you for submitting your response to the Lethbridge College Research Ethics Board's (REB) request for additional information regarding your submission. The REB has reviewed the additional information provided and feel that you have satisfied all conditions of approval. They have found the project be both sound and ethical within the limitations of research involving human subjects.

Your project has been approved for one (1) years at which time either a completion report indicating the number of participants, any adverse / unusual events, or an application for continuing research must be submitted. Also, please note that any substantive changes to methodology, ethical issues and/or complaints must be reported to the Board immediately. Please contact the REB Coordinator for more information on reporting and renewals.

Approval granted as of:	March 2, 2021
Documents reviewed:	General Protocol Review Form and supporting documents
Approval Expires:	March 1, 2022

Please note that approval by the Lethbridge College REB only pertains to research conducted under the auspices of Lethbridge College. If your research involves collaboration with other institutions you will require ethics approval from the partner's REB. Enquiries regarding institutional approval requirements should be directed to the appropriate person in each jurisdiction.

Sincerely,

Brad Wolcott
Chair

Research Ethics Board
ph. 403.320.3202 ext. 5787• Fax. 1-888-858-8517
3000 College Drive South • Lethbridge, AB T1K 1L6
appliedresearch@lethbridgecollege.ca
www.lethbridgecollege.ca

September 9, 2015

Protocol Number:	LC-21-08
Principal Investigator:	Laura Vogelsang
Project Title:	CareGiVR: Building Self-Efficacy in Dementia Care Through Immersive Education

The Lethbridge College Research Ethics Board (REB) has reviewed the application for an extension to the approval for the above protocol and have found the project be both sound and ethical within the limitations of research involving human subjects.

Your project has been approved for one (1) additional year at which time either a completion report indicating the number of participants, any adverse / unusual events, or an application for continuing research must be submitted. Also, please note that any substantive changes to methodology, ethical issues and/or complaints must be reported to the Board immediately. Please contact the REB Coordinator for more information on reporting and renewals.

Approval granted as of:	**March 2, 2022**
Approval expires:	**March 2, 2023**
Documents Reviewed and Approved:	**Protocol Extension/Modification Application for Extending and/or Modifying Approved Research Projects**
Conditions of Approval:	**• None**

Please note that approval by the Lethbridge College REB does not encompass authorization to access the staff or resources of any other institutions for the purposes of research. Enquiries regarding institutional approval requirements should be directed to the appropriate person in each jurisdiction.

Sincerely,

Dr. Sampath De Silva
Chair

Appendix C
Letter of Invitation
Study Title: **CareGiVR: Building Self-Efficacy in Dementia Care Through Immersive**

Education

Researcher(s):
Laura Vogelsang, RN, PhD(c), CMSN(c), CCNE, CCCI
Asistant Professor – Faculty of Health Sciences
3000 College Drive South, Lethbridge, AB T1K 1L6

What is this study about?
The CareGiVR project creates highly realistic virtual reality (VR) scenarios, using unique virtual clients, who can demonstrate a thorough range of emotions produced through performance (motion & facial) capture. Students and caregivers can practice responses in a variety of scenarios, receive immediate performance feedback and repeat as necessary for ongoing iterative learning without the costs and logistical challenges of a facilitated workshop. The use of VR in educational institutions has the potential to offer students more access to learning opportunities in a safe environment. Ideally, this should result in greater breadth and depth of knowledge development, ultimately resulting in better outcomes for the client when in the practice setting. In the short-term, this could result in new graduates who have more extensive knowledge bases and skills than they would have previously gained. This study aims to assess Practical nurse Students' perceptions of increased self-efficacy after using CareGiVR to manage aggressive behaviours in caring for clients with dementia and answer the following research questions:

(1) Does perceived self-efficacy improve for Practical nurse Students who use the CareGiVR application compared to those who do not, in relation to managing aggressive behaviors in clients with dementia?
(2) Are there any significant differences between Practical nurse students' perceived self-efficacy with managing aggressive behaviors in clients with dementia before and after using the CareGiVR application?
(3) How did practical nursing students perceive using the CareGiVR™ application influenced their self-efficacy with managing aggressive behaviours in clients with dementia?

Who can participate in this study?
All students in PNG 1154 2021-22 Term 2 Winter in Lethbridge will be eligible to participate in the study
Do I have to participate in this study?
While attendance at clinical is required as part of your program, participation in this study in completely voluntary and optional. Participation or lack thereof in the study will not affect student grades, coursework, or progress in the PN program.
What happens if I decide to participate?
All students in PNG 1154 will receive an email invitation to participate in the study. In the email you will be provided with a link to complete surveys using SurveyMonkey. The surveys will be anonymous and voluntary and will ask you to choose your relevant age range and gender. You

will then be asked to assess your perceived self-efficacy using the Inventory of Geriatric Nursing Self Efficacy (IGNSE) likert scale. Everyone will be asked to do the survey at the beginning of PNG 1154 clinical and after your final evaluation. You will be randomly assigned to an intervention and control group. If you are in the intervention group, you will be asked to use the CareGiVR Virtual Reality application and complete the survey a third time immediately following.

How will privacy and confidentiality be maintained?
The Lethbridge SurveyMonkey tool, which has a reputation for secure data protection will be used to deliver the surveys. All responses will be anonymous, IP addresses will not be tracked and data will be secured according to SurveyMonkey policies. Data collected will be kept in confidence in the principal investigator's office, either in a locked file cabinet or on her password protected computer for a minimum of 5 years after publication of study results.
If you participate in the focus groups your responses will be deidentified in the transcript. All responses will be confidential outside of those in the focus group.
Neither your instructor or practice coordinator will know if you chose to participate in the study.
Do I have the right to withdraw?
You may withdraw from the study at any time. Withdrawal from the study will not affect your grades, coursework, or progress in the PN program. To withdraw email laura.vogelsang@lethbridgecollege.ca
What are the potential benefits and risks associated with participation?
Participating in this study will give you the opportunity to provide feedback regarding the effectiveness of the CareGiVR application. Your input will help improve the CareGiVR platform and thus may improve outcomes for clients with dementia, healthcare providers and family members.
While participating in VR, you will be wearing a VR headset and headphones, which will totally block your view and understanding of position in the physical world. During this time, a facilitator will communicate to you through a microphone, which you'll be able to hear with your headphones. All obstructions such as cables and chairs will be cleared to minimize your physical risk. Additionally, a facilitator will monitor your physical movement and guide you if you're getting too close to an obstruction such as a wall or desk.

Some participants may experience motion sickness while in VR. Prior to your session, your facilitator will provide you these two suggestions if you experience motion sickness:

- close your eyes for a few moments and then open them
- if the motion sickness is severe, take off your VR headset immediately

As a Lethbridge College student you will have access to the Heath Centre on campus if you are feeling unwell following the use of the VR headset.

Virtual beings are designed to exhibit signs of anxiety and aggressive behaviour which cause distress to the participant. Lethbridge College Students still have 24/7/365 access to the Shepell

Student Support Program (SSP). The Shepell Student Support Program phone number not only allows students to access counselling and other scheduled services, it also acts as a crisis line, directly connecting students with a crisis counselor. Phone toll free: 1-855-649-8641

What if I have questions?
If you have any questions related to participation in this study, please feel free to contact the investigator listed at the top of this letter. This research project has been approved on ethical grounds by the Lethbridge College and University of Saskatchewan Behavioural Research Ethics Board on
March 29, 2022. Any questions regarding your rights as a participant may be addressed to that committee through the Research Ethics Office (403-320-3202 ext 5453).
Consent
When you log into SurveyMonkey you will be asked to provide your consent to participate.

How will I receive the results of this study?
The researcher may present results at regional, national or international teaching and learning conferences and submit publications to peer-reviewed journals. Participants can request to receive results.

Thank you for your consideration.

Sincerely,
Laura Vogelsang

Appendix D
Informed Consent

Name of Researcher, Centre, School, Telephone and Email:
Laura Vogelsang, Centre for Health and Wellness
Cellphone: (306) 321 2871
Laura.vogelsang@lethbridgecollege.ca

Supervisor:
N/A

Title of the Project:
CareGiVR: Building Self-Efficacy in Dementia Care Through Immersive Education

***Sponsor*:**
Funded through a $250K grant from Alberta Innovates

Researcher to Supply the Following (include the headings below in your consent form)

Purpose of the Study:
The purpose of the study is to determine if perceived self-efficacy improves for Practical nurse Students who use the CareGiVR application compared to those who do not, in relation to managing aggressive behaviors in clients with dementia.

What will I be asked to do?
You will be randomly assigned to one of two groups. If you are in the control group, you will be invited to complete surveys on SurveyMonkey at 2 separate times; pre and post the PNG 1154 clinical experience. If you are in the intervention group you will be invited to complete surveys on SurveyMonkey at 3 separate times; pre and post using the CareGiVR application, and after you have completed the PNG 1154 clinical experience. Completing the tasks in VR should only take about 20 minutes.
The pre survey will include demographics and questions regarding perceived self-efficacy using the Inventory of Geriatric Nursing Self Efficacy (IGNSE). The subsequent surveys will ask the Inventory of Geriatric Nursing Self Efficacy again to determine if there are any changes. The last survey will invite students to be contacted to participate in a focus group once the data has been analyzed.
Your participation in voluntary. If you would like to participate in the study, you will be asked to sign this consent form. Informed consent is an ongoing process, which means that at any time you may revoke your consent and withdraw from the study, without consequence. Although, if you do withdraw from the study, any data collected through your participation will be discarded and not included in the project. Please contact one of the researchers if you wish to withdraw.

What type of personal information will be collected?
While you are using the VR headset information such as your progress, and reaction times will be recorded and analyzed. If you choose to participate in the focus groups the sessions will be

recorded and transcribed. All files will be protected and used in compliance with Alberta's Freedom of Information and Protection of Privacy Act.

Are there Risks or Benefits if I participate?
While participating in VR, you will be wearing a VR headset and headphones, which will totally block your view and understanding of position in the physical world. During this time, a facilitator will communicate to you through a microphone, which you'll be able to hear with your headphones. All obstructions such as cables and chairs will be cleared to minimize your physical risk. Additionally, a facilitator will monitor your physical movement and guide you if you're getting too close to an obstruction such as a wall or desk.

Some participants may experience motion sickness while in VR. Prior to your session, your facilitator will provide you these two suggestions if you experience motion sickness:

- close your eyes for a few moments and then open them
- if the motion sickness is severe, take off your VR headset immediately

As a Lethbridge College student you will have access to the Heath Centre on campus if you are feeling unwell following the use of the VR headset.

Virtual beings are designed to exhibit signs of anxiety and aggressive behaviour which cause distress to the participant. Lethbridge College Students still have 24/7/365 access to the Shepell Student Support Program (SSP). The Shepell Student Support Program phone number not only allows students to access counselling and other scheduled services, it also acts as a crisis line, directly connecting students with a crisis counselor. Phone toll free: 1-855-649-8641

What happens to the information I provide?
Participation is completely voluntary. You are free to discontinue participation at any time during the study. To withdraw email laura.vogelsang@lethbridgecollege.ca. No one except the research team will be allowed to see the survey answers or view CareGiVR platform data. The results of the survey will not be made available until final grades are submitted. Only group information will be summarized for any presentation or publication of results. Survey results will be stored in a password protected system and will be permanently deleted after three years.

If you choose to withdraw before the end of the study, any information collected from your participation will be immediately deleted and not included in the results.

If you would like to receive a summary of the data from this study, please provide your email address

here: _____

Signatures (written consent)

Your signature on this form indicates that you 1) understand to your satisfaction the information provided to you about your participation in this research project, and 2) agree to participate as a research subject.

In no way does this waive your legal rights nor release the investigators, sponsors, or involved institutions from their legal and professional responsibilities. You are free to withdraw from this research project at any time. You should feel free to ask for clarification or new information throughout your participation.

Participant's Name: (please print) _____

Participant's Signature _____Date: _____

Principal Researcher's Name: (please print)
_____

Principal Researcher's Signature: _____Date:
_____

Questions/Concerns

If you have any further questions or want clarification regarding this research and/or your participation, please contact the researcher listed at the top of this letter.

If you have any concerns about the way you've been treated as a participant, please contact the Research Ethics Board Chair, Brad Wolcott, Lethbridge College at (403) 320-3202, extension 5721; email: brad.wolcott@lethbridgecollege.ca.

A copy of this consent form has been given to you to keep for your records and reference. The investigator has kept a copy of the consent form.

Appendix E

Inventory of Geriatric Nursing Self-Efficacy

Instructions: For each of the following situations, how confident are you that you could remain calm, resolve the problem, and achieve a positive outcome? (Please circle the appropriate number)

1. You are extremely busy, you are behind in your work, and one of the residents is following you around and trying to grab your arm.

Not at all confident 1☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ Very Confident

2. The husband of a newly admitted resident constantly instructs you on how to care for his wife. It seems that nothing you do is good enough for him.

Not at all confident 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ Very Confident

3. A nurse on your shift approaches you at the nursing station and demands to know why you are working so slowly.

Not at all confident 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ Very Confident

4. One of the residents often swears and curses at other residents and staff. While you are helping him with his wheelchair, he curses and nearly kicks you.

Not at all confident 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ Very Confident

5. You are at the nursing station and you see a resident's daughter walking briskly towards you. She looks very upset and angry.

Not at all confident 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ Very Confident

6. A colleague of yours is avoiding you for some reason. This is making your job difficult because you work closely with him.

Not at all confident 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ Very Confident

7. Every time you see one of the residents, she asks: "When do I get to go home?" This has been going on for months.

Not at all confident 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ Very Confident

8. The son of one of the residents corners you, blames you for ignoring his mother, and demands that you spend more time looking after her.

Not at all confident 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ Very Confident

9. A colleague of yours is constantly comparing herself to you, insisting that the residents and their families prefer the care she provides to your care.

Not at all confident 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ Very Confident

Appendix F

Research Question: How do Practical nurse students perceive the use of the CareGiVR application influenced their self-efficacy with managing aggressive behaviors in clients with dementia?

The statistical data has shown the students who did the Vivian scenario in VR had significant increase to their perceived self efficacy immediately after and higher self-efficacy scores than the control group after clinical

Note: Researcher will crowdsource a definition of what self-efficacy means. Writer can then share a definition of self-efficacy described in the literature to help participants understand the topic of interest being explored

Focus Group Interview Guide

1. Tell me about your experiences managing aggressive behaviors in clients with dementia during clinical
    a. What behaviours did you witness?
    b. What strategies were effective? Ineffective?
2. Tell me about your experience using the CareGiVR application
    a. Was the technology user-friendly?
    b. If you were to do the Vivian scenario over would you do anything differently?
3. Can you identify aspects of the CareGiVR application that influenced your sense of self-efficacy in managing aggressive behaviors in clients with dementia?
    a. What strategies were effective? Ineffective?
4. While you were in clinical at the practice site did you draw on your experiences from the CareGiVR scenario?
5. Could you envision CareGiVR and Virtual Reality being used in your program as way to build self-efficacy in dementia education?
    a. What would be an effective way to do this?
    b. What would make this not effective?
6. Is there anything you would change about the CareGiVR application? Or experience?
    a. Would anything make it better?
    b. Was anything missing?
7. Is there anything else you would like to share or add?

Appendix G

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2.1.1 FORM - Hazard Assessment Worksheet

Department/Faculty: CARIE/CHW	Laura Vogelsang	
Assessment Completed By: Laura Vogelsang	Date: Feb 3, 2020	Revision Date: MArch 2 2021

Type of Work/Activity	Hazard Type: (Physical, Chemical, Biological, Ergonomic, Environmental)	Risk (1-3) See below				Controls in Place	Controls Needed	To Be Completed By Department	Estimated Completion Date MM/DD/YY	Status
List all types of work done in this work area or job	List the hazards for each work related activity	Exposure Frequency	Severity	Probability	Total Rating	Engineered Administrative Personal Protective Equipment	List if any additional controls are required for that Hazard and the date they will be in place			
Participants will put on VR	Face to face contact	3	3	3	9	Physical distancing (2m) Face masks worn by participants and researchers. Researchers and participants will use hand sanitizer before and after.		Michael McCready		
Headsets demostration and given to participants	Exchanging materials	3	3	3	9	VR headsets and controllers will be wiped and santized before and after each participant Participants and researcher will put on gloves prior to handling equipment		Michael McCready		
Research will be operating computer	Work surface contact	3	3	3	9	Computer keyboards, mouse, and desk will be wiped and sanitized after each participant. Research will we gloves during sessions.		Michael McCready		
Carry out various tasks with a VR headset on	Limited Vision / Obstacles	2	2	2	8	Cords and other obstacles will be removed. A facilitator will monitor the participant and inform them when they are getting close to an obstacle.		Michael McCready		
Carry out various tasks with a VR headset on	Motion sickness / dizziness	1	2	2	6	Facilitators will provide instructions to participants if they are nausious.		Michael McCready		
		1	1	1						
		1	1	1						
		1	1	1						
		1	1	1						
		1	1	1						

Frequency Rating:
1. Low, less than 10% of work day
2. Medium, up to 65% of work day
3. High, over 66% of work day

Severity:
1. Minor, potential for minor injury
2. Moderate, potential for lost time injury
3. Severe, potential for severe injury

Probability:
1. Low, unlikely to happen
2. Medium, likely to happen
3. High, very likely to happen

Hazard Rating:
3-4 Low, requires monitoring
5-6 Moderate, requires attention
7-9 High, requires immediate attention

Appendix H

Notes transcribed to Microsoft Word Document

March 2/2022 [SN-KL]
So she was a bit interesting because she talked a lot more than then other two as she was with Vivian. Saying outloud what she was saying to the avatar. That was supposed to be the original idea so it's a good sign. I don't really know what she meant when she said that it 'was better than she expected' I guess that is something to consider and fits with the scoping review re: Gamers being more adept at using this tech… can't think of what paper that was ATM but I'll look. She definitely didn't need as much orientation as the other two.

*Stayed still and used the teleport feature – didn't move around in the space at all
I'm getting good at setting everything up … winner

March 14/2022 [SN-JC]
Okay so that was interesting. She was the first person who wasn't afraid to hug Vivian. I guess not 'afraid' but no one picked it and I'm not sure why, maybe they don't know how (tech) or there's more to this with therapeutic touch (self-efficacy?*). I guess if I was doing this and she had just tried to throw a brush at me that wouldn't be my first instinct either?

It's amazing how fast they all catch on – bless their hearts Gen Z!

I need to keep a mental note that everyone is "passing" the scenario so far no one has given up or gotten the 'bad outcome' was it too easy? I mean we weren't trying to have people fail but we shall see..
Today I'm tired – it's hard doing the picket shifts and the mental toll of the strike doing this. I think I need to take a break for the rest of the day

May 10/2022
Focus Group #2 Reflection
At times is annoying that we aren't in person, I don't think I would have to facilitate as much and I can't help but think this would be more organic than online. BUT its way easier now to go back and notice the body language and mannerisms. For instance [SN6] is super chatty. She definitely emerged as a main talker answering almost every question first.

The trend in the conversation was really fixated on how they felt, I guess the design worked to get them frustrated with the hairbrush, we might have to go back and look at that because the loop didn't seem totally realistic. It was interesting that they feel like it can't be a substitution for clinical hours when they have only done 40 hours of practicum so far and not actually started this rotation. So early in the program the student already sees clinical as more valuable than simulation? I guess they didn't say that… they said it can't replace it – maybe its valuable but in a different way… they did mention a few times how the fact they could practice over and over was important and not be evaluated. But really, students don't ever want to be observed being evaluated so that's not earth shattering.

Is it right to say it's a hierarchy of how we value learning? Between simulation (VR) and clinical?
Parking lot that for now…