

# Virtual Simulations in Nursing Education: A Scoping Review

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## Review Article

### ABSTRACT

**Objective:** Nurse Educators have recently started offering students virtual experiences as a way to apply theory and develop problem-solving skills. The purpose of this scoping review is to examine virtual simulation in nursing education and to summarize and disseminate the results.

**Design and review:** Arksey and O'Malley's scoping methodology was used as a framework for the review.

The databases searched included: PubMed, Medline, CINAHL, ProQuest and ProQuest Dissertations.

**Results:** Twenty-two articles from 2009 to 2014 met the search criteria. The majority of the studies included undergraduate nursing students. The articles were analyzed and three themes emerged: student outcomes, student and faculty challenges with virtual simulation.

**Conclusion:** Learners were largely very positive about virtual experiences and outcomes were comparable or better than those obtained with traditional simulation activities. Virtual simulations have the potential to eliminate geographical boundaries, provide a safe learning environment, and offer a teaching strategy familiar to our students. More research is needed to determine the most effective way to implement virtual simulation into curriculum.

**Keywords:** Nursing education; Computer simulation; Educational technology; Scoping review

### INTRODUCTION

The recent introduction of virtual simulation (VS) in nursing education may appeal to the current generation of learners who do not know a world without computers or other hand held technology. Recently, nursing schools have begun to offer students opportunities to apply knowledge and skills to realistic VS of client cases. Some studies in health care education suggest that VS may have advantages over in-person simulation methods <sup>[1]</sup>. As nurse educators start to embrace this educational innovation, there is a need to review the body of evidence associated with VS. This scoping review will examine the use of VS in nursing education.

### BACKGROUND

The classroom, the laboratory and clinical placements are the traditional settings where nursing education has prepared students for practice. Each setting serves a specific, valuable purpose; classroom experiences expose students to essential knowledge and skills and clinical placements provide a place for students to encounter the real world and apply their newly acquired knowledge under the supervision of experienced nurses. The laboratory practice setting serves as the bridge between the classroom and clinical placement. In the laboratory, students are provided with opportunities to safely apply their knowledge, develop their problem solving and psychomotor skills and the confidence required to safely practice as novice practitioners. Traditionally, a wide variety of teaching techniques have been used in the

laboratory ranging from instructor demonstration and student return demonstrations to complex simulations designed to replicate client situations. Recent advances in the technology of high fidelity mannequins have contributed to the creation of highly realistic simulations that provide students with immersive experiences. The use of immersive or high fidelity simulation has an important advantage over clinical placements. As part of the simulation delivery process, students receive faculty feedback on their performance and have opportunities to repeat simulations in safe environments that allow for mastery prior to being assigned to care for acute care clients in clinical practice [2,3].

Study results suggest simulations, which include computer-based simulations, may effectively replace a certain percentage of clinical experiences [4]. This finding is of considerable interest to nursing faculty who experience challenges in obtaining quality clinical placements, particularly in specialty areas such as labor and delivery or pediatric care [5]. There is, however, a major barrier to medium and high fidelity simulation laboratories; the cost to create, operate and maintain them can be prohibitive [6].

In recent years, health care education has experienced an exponential growth in adopting technology. More recently, high fidelity simulation has been developed for online format delivery, similar to the virtual immersive games played recreationally. VSs are designed to provide nursing students with an opportunity to engage with clients in a realistic virtual world. VSs are self-contained and accessible online 24/7, eliminating some of the limitations associated with laboratory simulations. While VSs appear to address some of the challenges regarding preparation for professional practice, it is critical to evaluate the impact of this new technology before wide-spread adoption in nursing education.

The purpose of this scoping review is to examine the literature in order to gain an understanding of the current evidence regarding VS. It is helpful to understand the difference between a systematic and a scoping review. The purpose of a scoping review is to, “aim to map rapidly the key concepts underpinning a research area and the main sources and types of evidence available” [7]. A systematic review reports and critiques a subset of the articles whereas a scoping review describes the results of all studies reviewed and does not critique the quality of research methodology [8]. This scoping review is expected to help inform nurse educators who wish to integrate VS into their teaching and to give direction to future research.

## THEORETICAL FRAME WORK

The burgeoning use of VS in nursing education makes the scoping review methodology a useful approach in which to explore the literature. A five-step review model based on Arskey and O'Malley's [8] scoping review model, later refined by Levac et al. [9] was used to structure the review.

## METHODS

### Stage 1: Identifying the Research Question

Before we could identify the research question, we had to clarify the terminology for the scoping review. A plethora of terminology was found in the literature to describe computerized or virtual reality simulation. Common terms included virtual reality, immersive reality, non-immersive reality, virtual community, computer-generated simulation, computerized simulation, VS, virtual gaming and serious gaming. All too often, researchers did not provide definitions for their terms which further complicated the picture. For the purpose of this scoping review, a VS was defined as computer-based simulation that included; a) a realistic client case study; b) an activity requiring knowledge application; and c) learner engagement in the role of the care provider.

The review was designed to answer the question: What is known about student attitudes, experiences and outcomes associated with VS in nursing education? We focused the review on nursing literature to determine the amount of work done in this profession. We decided not to narrow the search to specific types of outcomes to better understand the broad impact of VS.

### Stage 2: Identify Relevant Studies

The literature search was conducted in five electronic databases: PubMed, Medline, CINAHL, ProQuest and ProQuest Dissertations. These databases were selected because of their comprehensive inclusion of nursing literature. The search was limited to studies published from January 1, 2009 to July 2014 to capture recent exponential advances in computerized or virtual gaming technology. Searches were limited to the English language due to a lack of resources for translation services. Thesis and dissertations were included in the review since they reflected the most current research. The target population for the review was undergraduate nursing students then we expanded to add studies that directly referred to nursing education. Revising the parameters of the search strategy is consistent with an iterative scoping review process [8,9]. The terms used for the search are listed in **Table 1**.

**Table 1.** Literature search strategy.

The search included variations of the following terms in each column (OR) and the Boolean connector of AND connected the terms in the three columns. Search restricted to: studies, reviews and research		
Nursing educat* (educator, education)	Computer	Simulation
Nursing bac*(baccalaureate, bachelors)	Techn* (technology, technical)	Case study
Nursing Degree	On-line	
Nursing diploma	Virtual	
Nursing students		

**Stage 3: Study Selection**

A total of 123 articles were retrieved and the two principal authors independently reviewed the abstracts and articles for inclusion. Only the articles that met the study’s inclusion criteria were retained for full review: 1) the articles met the definition of “VS” proposed by the authors; 2) included nursing students or focused on nursing education; 3) included research findings (i.e., proposed studies were excluded). Additional manual searches of the references of selected articles were conducted until saturation was achieved, meaning, that only the previously selected studies were being referenced and no new studies could be identified. When the independent reviews by both authors of each study was completed by both authors, results were compared. A total of 22 studies were identified for inclusion in this review is important to note that two literature review articles were identified in the literature and included in this scoping review search [10,11].

**Stage 4: Charting the Data**

The next step in the review was to chart the data, a process described by Arksey and O’Malley [8], where researchers identify the key information they want to report and then comb through the articles to retrieve that information. Identifying key information elements helps the researchers be consistent in their reporting thereby increasing the utility of the report for the reader.

The principal authors extracted the following elements from each article into a master data chart: study details, objectives, virtual platform, methodology and main findings. The charting process was very helpful in organizing the data and identifying common themes in the literature. The article review for each study was independently conducted by the two principle authors. The findings were compared after which differences were discussed until consensus was reached. The process of using two reviewers enhanced the reliability of the data collection and analysis.

**Stage 5: Collating and Summarizing the Results**

Once the data had been charted, the principal authors reviewed the data then identified the key themes that emerged from the articles. To validate those findings, a consultative review process occurred with three nursing faculty.

**RESULTS**

**Technology Platforms**

Several different virtual platforms were reported. One was the neighborhood, an innovative online virtual community that included culturally diverse characters of different ages, with different disease processes. Second Life was a second multiplayer online virtual world where students created virtual representations of themselves in the form of avatars to interact with places, objects, and other avatars. A third virtual platform was the Web-SP, a virtual patient system where teachers created cases to develop specific learning outcomes. Other studies used a virtual skills-based process such as a catheter insertion like CathSim or Voki (talking) avatar platforms. In all of these platforms, learning objectives are provided and learners are expected to select or identify actions based on the client scenario or skills presented in the case study. Generally, feedback on to learners in the form of avatar responses requiring additional actions/responses on the part of the learner, or learners receives virtual feedback from the instructor.

**Research Methodology**

The majority of studies reviewed were quantitative descriptive studies. The next largest category was qualitative studies that focused on students’ attitudes or perceptions of their experience with VS (Table 2). Other articles retrieved were mixed method, experimental/quasi-experimental and usability studies. The studies generally measured self-

efficacy, satisfaction, knowledge, application of concepts and knowledge retention. The usability studies examined the ease and usefulness of applying VS in nursing education. Two literature reviews examined the status of avatars and assessed the evidence for using virtual worlds in nursing education. One cluster of studies was based on the virtual platform, 'The Neighbourhood'. The second most frequently studied virtual platform was 'Second Life'. The remainder were individual platforms from existing software. The studies had broad global representation: the United States of America (15), Sweden (3), Seoul Korea (1), Hong Kong (1), Brazil (1), and the United Kingdom (1). The majority of participants were nursing students from baccalaureate programs. All the articles were from peer-reviewed journals.

**Table 2.** Summary of articles.

Study Sample	Objective	Virtual Platform	Methodology	Main Findings
USA 75 2nd semester nursing students [12]	Perceptions of using Voki avatar case studies in nursing pharmacology	Voki Avatar	Descriptive, quantitative	-Students reported the virtual case studies as fun, engaging and meaningful -Helped to apply pharmacology content
Brasil 25 nursing students [13]	Develop, implement and evaluate the ergonomics, pedagogical and usability of a web-based simulation for critical care nursing	VS developed using a combination of software	Descriptive, quantitative	-Web-based simulation was feasible and enhanced the learning process -Participants were satisfied with the VS environment -The VS was easy to navigate
USA 281 first year BScN nursing students [14]	Assess the primary benefits and challenges of VS and the relationship between learner benefits and challenges	The Neighborhood	Mixed method	-The benefits of the VS outweighed the challenges -Benefits increased when faculty were well trained and used VS frequently
Hong Kong 206 nursing students [15]	Use the Technology Acceptance Model to assess Second Life for students learning rapid-sequence intubation	Second Life	Descriptive, quantitative	-Students reported the VS was useful -Students with stronger computer skills reported greater benefits
USA 12 reviewed studies with a total of 504 participants from nursing, sports science, medicine, forensic science [10]	Identify the evidence for using 'virtual worlds' in nursing and health professions education		Integrative Review	-Virtual worlds in nursing education could be an effective way to teach nursing and health concepts because of the safe, interactive, immersive learning experience -Virtual worlds enhance knowledge, skills and competence -Challenges include technology, cost, accessibility, and development time of virtual experiences
USA 41 Associate degree nursing students [16]	Longitudinal study of the effects of virtual reality (VR) simulation: Both groups completed web-based modules, then the intervention group completed a VR simulated disaster	Second Life	Longitudinal experimental design	- VR and control groups made similar gains in the immediate post knowledge assessment -Two month knowledge test showed stability in the VR group and decline in the control group -Cost effective training when compared to live drills
USA 281 first semester BScN students [17]	Compared differences in perceived learning benefits among nursing students with different learning styles and the frequency of VS use	The Neighborhood	Descriptive, quantitative	-No perceived differences regarding benefits according to learning style -Learners who used the VS more frequently reported significantly greater learning benefits
Sweden 77 BScN students [18]	Assess clinical reasoning using VS	Web -SP	Descriptive, quantitative	-VS was an engaging, realistic way to be assessed on clinical reasoning and decision making skills

USA 350 BScN students [19]	Assess the relationship between the frequency of virtual community use and perceived benefits in diverse students groups	The Neighborhood	Descriptive, quantitative	- Greater benefits were reported among minority students and the strength of perceived benefits increased over time among all learners.
USA 342 first semester BScN students [20]	Assess the virtual community as a teaching application to foster cultural awareness	The Neighborhood	Descriptive, quantitative	-There was a significant positive correlation between frequency of use and cultural awareness
USA 246 BScN students [21]	Assess differences in perceived benefits related to demographic characteristics and the impact of benefits over time	The Neighborhood	Descriptive, quantitative	-Greater benefits in connecting virtual characters' health problems with course concepts in underrepresented minorities and students who anticipated a grade lower than A -Perceived learning benefits with usage over time
Sweden 22 2nd year BScN students [3]	Investigate learning gained by using computer simulation skills training	CathSim	Descriptive, quantitative	-Students benefited by having a variety of clients and immediate feedback. They reported increased understanding of vein catheterization and confidence in the clinical setting -Students missed holding an arm or using a model
USA 126 BScN students [22]	Measure effectiveness of VS as a teaching strategy and identify technical barriers	Second Life	Descriptive, quantitative	-Moderately effective as a teaching strategy -Students could make mistakes without consequences -Able to learn from home -The greater the technical challenges, the lower the educational benefit reported -Avatars took time to create and were difficult to move
USA 218 nursing students [23]	Assess experience and attitudes with computer games and new media technologies and their role in education		Descriptive, quantitative	-All students reported a positive experience and were positive about the potential role of video games and related new media technology in education
UK-Scotland 5 3rd year BScN students [2]	Assess decision making skills	Second Life	Qualitative exploratory	-Clinical decisions made by users of Second life were made reactively instead of proactively -Virtual worlds could facilitate students' clinical decision making
USA 18 articles >1,072 participants [11]	Assess current avatar use in nursing education		Integrative review	-Learners reported an increased connection to the learning situation when using avatars that improved learning and satisfaction -Richer discussions with the avatar experience when compared to asynchronous forums -Improved confidence and skills due to safe practice environment -Technical concerns related to computer lag times, navigation and communication problems
USA 77 nurses [24]	Assess nurses' attitudes regarding the use of	Second Life	Descriptive, quantitative	-Positive attitude toward exploring the use virtual environments within distance education

	immersive virtual environments			
Korea 213 2nd year nursing students [25]	Compare computer-based simulation and instructor led resuscitation training in students' self-efficacy, post code stress and satisfaction	MicroSim In-Hospital Self-Directed Learning System	Experimental post-test design	-No statistical significance between the control and intervention groups in self-efficacy, post-code stress and satisfaction
USA 40 BScN students [26]	Assess student experience using The Neighborhood in education	The Neighborhood	Qualitative	-Users felt emotionally connected and integrated to the virtual community which supported the learning process
USA 247 BScN students [27]	Compare the quality of interview questions and responses in students with/out avatar interview experience	Second Life	Mixed methods	-Participants in the avatar group asked more sensitive sexual health questions and obtained a more thorough health history than non-Avatar students
USA 184 accelerated, second-degree nursing students [28]	Assess the effectiveness of virtual nursing internships in helping students learn community nursing practice concepts	virtual nursing "internships"	Quasi-experimental pre-post test	-Equal outcomes in students who received the virtual internship and those who did not regarding knowledge gains and attitudes towards community-orientated nursing  -Engaging approach to conveying the richness and interrelatedness of public health practice  -Faculty felt an increased ability to teach certain concepts

### Thematic Analysis

The three major themes that were identified in the thematic analysis; included student outcomes, student challenges with VS and faculty challenges with VS.

### Student Outcomes

The majority of studies described the nursing students' experiences with the VS. VS was reported as being fun, easy to use, motivating, provided a satisfactory learning experience [11,12,15,16,23,24,26-28] and effective in reaching geographically dispersed students [24]. When compared with more traditional modes of learning, many students felt more connected and experienced greater learning and satisfaction [11]. In some cases, when the virtual experience was compared with a traditional experience no significant differences were found, however, the students in the virtual experience reported their learning was 'fun' [28].

The majority of authors reported positive findings related to satisfaction, self-efficacy, learning, engagement and psychological safety [10,27,28]. Farra et al. [16] found VS has the potential to reinforce learning and improve learning retention. Students appreciated the ability to repeat the learning experience to potentially reach mastery in a psychologically safe environment [11]. With VS there seems to be an emotional attachment to the virtual characters which students felt supported their learning and helped to understand concepts [26]. However, Roh et al. [25] in a study comparing virtual and traditional 'code blue' simulations reported no significant difference between VS and non VS groups in self-efficacy, post-code stress and satisfaction.

Effectiveness as a teaching strategy related to knowledge and course outcomes has received less attention. Some studies suggested that VS can be effective regardless of student learning style preference [17] and with students from different cultural backgrounds [21]. Work by Giddens et al. [20] suggested that VS (the Neighbourhood) promoted student development of cultural awareness. Some of the studies found the use of VS for non-technical outcomes such as communication, problem-solving and team work to be a viable strategy [11,20,27]. Other VS were effective in developing technical skills such as intravenous insertion and cardio-pulmonary resuscitation [3,25], however, some students missed physical contact with a manniken. There is preliminary data for VS as an effective medium to assess or enhance student's clinical reasoning and decision making skills [2,18].

## **Student Challenges with VS**

Reports of the technical experience when VSs were used featured in almost every study reviewed. Students highlighted the need for VS technology to operate smoothly and they emphasized the importance of clear instructions to help them get started [13].

The impact of the VS was obscured in several studies because learners experienced technical problems using the simulation. Kidd et al. [22] reported a significant negative correlation between the number of technical issues and students' perceived educational benefits. Additionally, students who had access to older model computers rated the experience as less effective than students using newer models [22], Forsberg et al. [18] indicated a need for student online training and additional technical support in the classroom and online to address the technical needs of students engaging in VS experiences. Anderson et al. [11] reported student frustration with the technology when there was insufficient space for entering text responses or with limited platform/browser capabilities.

Barbosa and Marin [13] was one of the few researchers who reported completing a usability study before implementing and testing the virtual world experience. The study found that students appreciated the high quality video and sound; the encouraging messages built into the simulation; and the ease of use built into the simulation design [13]. Usability studies contribute to the designers' ability to enhance the virtual experiences prior to studying the impact of VS in nursing education [15].

## **Nursing Faculty Challenges**

Study after study indicated that faculty uptake is critical for successful VS implementation. A positive correlation was reported between faculty acceptance and competence with VS and the student experience; the greater the frequency of faculty VS use, the greater the perceived benefits reported by students [14]. Several studies suggested that faculty markedly influenced the successful integration of VS into courses, suggesting the importance of faculty development and engagement when using VS [10,19].

Faculty also reported challenges related to program malfunction and lack of technological support [22] when implementing VS. These authors recommended more training for faculty regarding design and facilitating these types of educational experiences for students.

## **DISCUSSION**

A five-stage scoping review, following the framework described by Arksey and O'Malley [8] was conducted and several broad findings were identified. One challenge was the inconsistent terminology used to describe VSs as well as the lack of clear definitions of the technology. VS is an emerging specialty; clear definitions are foundational to understanding the different VS products and providing direction for education and research. Recently, the Healthcare Simulation Dictionary was produced with definitions for VS [29]; researchers are encouraged to use it to promote clarity and consistency. This review also identified the need for more fulsome descriptions of the many different variations of VS interventions being used and studied.

The participants in the review in general exhibited enthusiasm for VS as a teaching strategy in nursing. Similar to other studies of health care providers [30], nurses felt psychologically safe testing their decision making when using the technology to prepare for practice. Learners were largely very positive regarding their VS experience and outcomes were comparable or better than those obtained with traditional simulation activities. These findings are encouraging to faculty who are exploring innovation in technology and provide support for further development and implementation of VS. Further, the findings of this review are supported by an earlier scoping review, albeit with health care providers as well as students [1]. More research is now needed to determine the most effective way to use VSs in the curriculum.

Nursing professors are well-versed in the theory that suggests students learn in a variety of ways and that our diverse student populations should be exposed to a range of learning experiences. VS is a recent addition to our teaching and learning toolkit that we can offer students to augment their clinical experience and help with the transfer of theory to practice. VS has also started to show some promise in meeting the learning needs of ethnically diverse student populations and students with different learning styles.

The most interesting and compelling educational technologies, however, will not succeed unless nursing faculty and students are comfortable using them. Training and on-going support to use the technology and to implement it effectively in the curriculum is essential. A recurring theme in the studies reviewed was that students become frustrated when navigating clumsy systems independently. The importance of usability testing for VS, to ensure products are easy to learn to use and appear useful cannot be overstated.

## **Implications for the Future of Research and Practice**

The results of this scoping review can be useful in guiding the implementation of VS in nursing education and identifying research gaps. Our nursing students are technology savvy and interested in learning through VS, however, there is a gap in understanding how best to prepare nursing faculty to effectively implement VS in the curriculum. Further research is also needed to compare different VS platforms in relation to achieving outcomes and to determine the impact of VS on clinical practice. In addition, studies are needed to assess if VS experiences directly impact patient outcomes. There is also a need for studies related to specific learning outcomes such as critical thinking or ethical dilemmas so that nursing faculty can best match specific learning strategies to outcomes. Peddle's, et al. integrative review of technology enabled simulations found they support health care providers development of nontechnical skills such as communication and teamwork, studies of nursing students will help to determine if the results are consistent. While Duff, et al. scoping review found health care providers using online VS had similar or higher outcomes related to engagement and learning when compared to traditional simulations [1,31].

## **LIMITATIONS**

A strength of this scoping review is that it provides breadth and depth in the review of the studies that have been completed in the VS field. However, the quality of the research reported in this review was not evaluated and that is a limitation of the scoping review methodology approach. Another limitation is that the scope of this review was restricted to studies in nursing education; no doubt there are useful studies that report the use of VS with other health care disciplines. Unpublished abstracts and conference posters and presentations, were not included in this review, therefore valuable current findings relevant to this emerging field may have been omitted.

## **CONCLUSION**

VSs have the potential to eliminate geographical boundaries, safely prepare students to care for their clients, and offer a learning experience that is interesting and familiar to our tech savvy students. This scoping review was conducted to assess and analyze current studies on the use and success of VS in nursing education. The results will be useful in informing future research and providing direction for the development of VS in nursing education. Future studies will help to determine the extent in which VS can support learning.

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