

## ORIGINAL RESEARCH

# Assessing the effectiveness of nursing virtual reality simulation for English as second language students to decrease anxiety in clinical courses

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## ABSTRACT

This study aimed to assess the effectiveness of Nursing Virtual Reality Simulation (NVRS) in increasing confidence and reducing anxiety among English as a Second Language (ESL) students enrolled in undergraduate nursing clinical courses. ESL nursing students often face unique challenges in clinical settings, where effective communication and critical thinking are crucial. With the growing use of NVRS as an innovative component of nursing education, this study employed a mixed-methods approach, including a pre-intervention survey and a post-intervention Likert-scale questionnaire, along with individual interviews, to evaluate the outcomes of two NVRS sessions. Preliminary findings suggest that NVRS significantly reduces anxiety related to language barriers, enabling ESL students to practice and improve their communication skills in a supportive, immersive environment. The positive feedback from participants underscores the potential of NVRS to enhance clinical learning experiences. The study concludes that NVRS could be an effective supplementary tool in reducing anxiety among ESL nursing students, and further research is recommended to explore the long-term impacts of NVRS on clinical performance and confidence.

**Key Words:** Virtual reality, Nursing virtual reality simulation, English as a second language, Nursing student, Clinical, Anxiety

## 1. INTRODUCTION

Undergraduate nurse education faces increasing challenges such as faculty shortages, limited access and capacity for simulation, limited access to clinical sites, and a lack of diversity among nursing faculty with continued lack of diversity among nursing students.<sup>[1]</sup> Nursing competencies, such as interpersonal communication, clinical decision-making, reasoning and judgment, and relevant technical skills are essential in the development of competent student nurse graduates.<sup>[2,3]</sup> Undergraduate nursing students, especially junior students, experience high levels of anxiety when they enter the clinical setting. This anxiety can negatively impact

their development of clinical skills and critical thinking.<sup>[4]</sup> This is potentially more challenging when these situations occur among minority students, such as English as second language (ESL) international students. Communicating in a second language within clinical settings may intensify the anxiety experienced by ESL nursing students, leading to feelings of fear, worry, and concern about being judged by others.<sup>[5]</sup> ESL nursing students encounter distinct challenges in clinical education, often grappling with language barriers, cultural differences, and a lack of familiarity with medical terminology in English.<sup>[6,7]</sup> These challenges can lead to heightened anxiety and diminished confidence, adversely

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affecting both their learning experience and clinical performance. Anxiety in clinical settings is not just an educational hurdle for ESL students, but also a potential risk to patient safety and care quality, as instructors cannot be present for every nursing intervention performed by students. As a fundamental consideration in clinical education, safety needs to be addressed before nursing students take care of patients.

All these challenges necessitate the consideration and development of new teaching strategies as supplements to the traditional classroom and clinical teaching. New teaching strategies should be able to help ESL students address their anxiety in clinical settings with limited access to clinical sites and a lack of faculty. Recent advancements in nursing education have been marked by the integration of innovative teaching methodologies, notably virtual reality (VR) simulations.<sup>[8]</sup> Nursing school leaders and administrators have been contemplating the integration of VR into simulation courses. These simulations offer an immersive, interactive learning environment that allows nursing students to acquire hands-on experience in a safe, controlled setting.<sup>[9]</sup> Studies have demonstrated that VR simulations can significantly enhance clinical skills, decision-making abilities, and confidence among nursing students.<sup>[10,11]</sup> Brown et al. emphasized the growing need for high-quality virtual experiences in nursing education and they suggested that virtual simulation (VS) learning should be integrated into nursing curriculums and aligned with program and course objectives, following the INACLS Standards of Best Practice.<sup>[12]</sup> VR, an interactive Internet-based technology capable of simulating real-life procedures and environments, enables students to engage in the unlimited practice of procedures with prompt feedback.<sup>[13-15]</sup> Should VR enhance students' performance and be utilized widely in simulation courses, it could serve as a valuable solution to the challenges of faculty and site shortages for undergraduate nursing schools.<sup>[16]</sup> Simulation may improve ESL students' understanding of nursing knowledge, skills, and procedures, thereby reducing their anxiety, and enhancing preparation prior to beginning clinical courses in the hospitals.<sup>[17]</sup>

Recent research concerning the applications of Nursing Virtual Reality Simulation (NVRS) within undergraduate clinical education has increased. These studies received focus in part due to the COVID-19 pandemic.<sup>[18]</sup> The pandemic has exacerbated both the shortage of nursing faculty and the lack of clinical sites.<sup>[19]</sup> Therefore, many nursing school leaders are integrating VR tools into simulation courses. NVRS enables students to practice nursing procedures repeatedly, receive rapid feedback, and avoid any harm to patients in real life. NVRS, as a supplement teaching strategy, mitigates the issue of faculty shortage in academia and alleviates hos-

pital nurse shortages. Nursing educators need to improve teaching strategies and utilize rapidly developing modern technologies as supplements to traditional education methods. Students equipped with the capabilities to address the challenges of the current and future complex healthcare environment experience less anxiety. Few studies however focus specifically on the effectiveness of NVRS for anxiety reduction among undergraduate nursing students, particularly those who are ESL students. The purpose of this study was to assess the effectiveness of NVRS as an intervention to increase confidence and reduce anxiety for ESL students enrolled in undergraduate nursing clinical courses. This study, conducted at a prelicensure nursing program, assessed the effectiveness of the NVRS application in reducing anxiety among ESL students before their clinical course. With this work, we are expecting to gain a better understanding of the effectiveness of NVRS in alleviating anxiety among ESL nursing students and improving the learning outcomes of their simulation courses.

### 1.1 Literature review

A comprehensive literature review was conducted to summarize findings concerning the effectiveness (such as the improvement of student performance) of VR simulations in nursing education. The literature review included three electronic databases, PubMed, CINAHL, and Cochrane Library.

According to Dutile et al., VR is an interactive Internet-based technology used in clinical education that enables students to engage in clinical simulations within a safe environment.<sup>[20]</sup> VR offers a promising approach to imparting knowledge and skills to nursing students, particularly in the context of clinical simulations. Some researchers have stated that VR has become a critical tool for educating future nurses amid the global health crisis.<sup>[21]</sup> Furthermore, VR can be utilized to provide training not only for nursing students but also for experienced nurses, allowing them to simulate real-life experiences under various conditions.<sup>[22]</sup> Thus, several studies have examined the application of VR in nursing education and have described the positive effects of this new technology. D'Errico discovered that VR was effective in problem identification and solution gathering, and it could successfully present scenarios to nursing students, fostering stronger connections among team members.<sup>[23]</sup> Jenson & Forsyth concluded that VR enables students to make mistakes without causing real harm to patients, and it allows them to experience diverse patient conditions and rare procedures with receiving quick feedback.<sup>[16]</sup> Kardong-Edgren et al. stated that the use of VR games for refreshing sterile urinary catheterization skills had a positive impact and was enjoyable for students.<sup>[24]</sup> Smith & Hamilton concluded that

students using VR simulations achieved higher performance scores.<sup>[25]</sup> Further studies by Smith et al. reinforced this view and emphasized that VR simulations can offer alternative learning experiences for nursing students.<sup>[26,27]</sup> As highlighted by Chang et al., when assessing the effectiveness of VR in nursing education, it is crucial to concentrate on the student's performance and their ability to deliver safe nursing care.<sup>[28]</sup> Nurses are responsible for making critical decisions that directly impact on the safety of patients. Thus, it is crucial for nursing students to acquire clinical decision-making (CDM) skills, which often cause anxiety among novice nursing students and impact their performance in simulation classes.<sup>[29]</sup> Nursing students typically perceive new clinical environments as threatening stimuli.<sup>[30]</sup> How to decrease anxiety and increase the confidence of nursing students before they enter the hospital for their clinical course has been a challenge for most nursing educators and programs. Kidd et al. provided positive feedback on VR applications, particularly highlighting the convenience of using VR from home without the fear of making mistakes.<sup>[31]</sup> Padilha et al. conducted an experiment on clinical virtual simulation in nursing education and concluded that VR simulation could significantly enhance students' knowledge and confidence in CDM.<sup>[32]</sup> Some other studies on augmented reality (AR) and mixed reality (MR), which involve similar VR technology, have demonstrated a higher degree of confidence among students.<sup>[33]</sup>

However, few studies have been conducted on the effectiveness of VR in decreasing anxiety among ESL nursing students, who often experience heightened anxiety due to language issues.<sup>[5]</sup> According to Choi, a key concern in the education of ESL nursing students is their ability to communicate effectively in English both in the classroom and in clinical settings.<sup>[34]</sup> With an increasing number of ESL students pursuing nursing degrees, second language anxiety (SLA) adds additional pressure on these students before entering a new clinical environment. It is necessary for nursing educators to provide support to ESL students to ensure their success in nursing studies and future careers. Various strategies have been introduced to assist ESL nursing students, including improving their English language skills, actively engaging them in classes and clinical experiences, and providing additional practice opportunities.<sup>[35]</sup> These strategies aim to help ESL students overcome language, culture, and academic barriers.<sup>[36]</sup> However, the personal pressure and anxieties experienced by ESL nursing students before their first clinical practice have yet to be effectively addressed. Therefore, it is worthwhile investigating the effectiveness of VR in reducing anxiety among ESL students during their clinical course.

## 2. METHOD

### 2.1 Theoretical framework

Kolb's experiential learning theory, which posits that knowledge is constructed through direct experiences rather than solely from didactic instruction provided the theoretical framework for this study. This theory is instrumental in understanding how learners assimilate and process new information through interactive experiences.<sup>[37]</sup> Kolb's model categorizes learners based on their abilities in four areas: Concrete Experience (CE), Reflective Observation (RO), Abstract Conceptualization (AC), and Active Experimentation (AE). These categories provide a comprehensive framework for examining learning processes, especially in simulation-based environments like NVRS.<sup>[38]</sup>

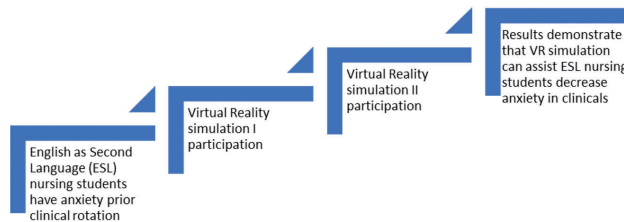
ESL undergraduate nursing students often encounter unique challenges, primarily due to language barriers and cultural differences in learning environments. Kolb's theory, as applied to these students, suggests that they can significantly benefit from immersive and experiential learning opportunities through repeated exercises and training. Knutson highlights the enhanced educational outcomes when ESL students engage in learning activities that transcend traditional linguistic approaches.<sup>[39]</sup> Furthermore, Kelly underscores the utility of Kolb's model in helping learners, particularly those facing language barriers, in identifying and leveraging their strengths while addressing areas for improvement.<sup>[40]</sup>

In this context, NVRS emerges as a promising educational tool, providing ESL nursing students with an enriched learning platform. This simulation technology aligns seamlessly with Kolb's learning dimensions, offering:

- CE: Immersive clinical experiences in a virtual environment.
- RO: Opportunities for reflective practice post-simulation.
- AC: Theoretical understanding through interactive learning.
- AE: Application of learned skills in simulated settings, preparing students for real-world clinical scenarios.

In this study, we developed the Simulation-Integrated Virtual Reality Learning Model (SIVRLM), which was conceptualized based on Kolb's theory. The SIVRLM, as depicted in Figure 1, illustrates the integration of VR in nursing education, tailoring the experiential learning cycle to the specific needs of ESL students through repeated participation in the virtual simulation sessions. The SIVRLM encapsulates a systematic approach, ensuring that ESL students engage in a comprehensive learning cycle that enhances both their language proficiency and clinical competence. This study, conducted within a prelicensure nursing program, serves as an initial test of the SIVRLM. This study utilized a quasi-

experimental design including ESL nursing students who participated in NVRS sessions (intervention) and completed post-simulation surveys. These surveys aimed to evaluate the impact of NVRS on the students' learning experiences, particularly in terms of confidence and anxiety reduction in clinical settings.



**Figure 1.** Simulation-Integrated Virtual Reality Learning Model

## 2.2 Participants and sampling

This study focused exclusively on ESL undergraduate nursing students enrolled in a prelicensure Bachelor of Science in Nursing (BSN) program. The primary criterion for inclusion was that the participants' first language is not English, thereby categorizing them as ESL learners. This demographic was specifically chosen to understand the impact of NVRS on nursing students who face unique challenges due to language barriers in their educational journey. The study was conducted at a well-established BSN nursing program in the Southwestern United States, during the Fall 2023 academic semester. The choice of location and timing was strategic, considering the diverse student population in the program and the relevance of the study period to the academic curriculum. A total of 25 ESL nursing students responded to our recruitment, and 17 of them were identified for inclusion (8 were excluded due to time conflicts in classes) in this study, employing a random sampling method. This approach was chosen to ensure a representative cross-section of the ESL student population within the traditional track of the nursing school. Random sampling aimed to reduce selection bias and enhance the generalizability of the study findings.

Prior to participation, all students were required to sign a participant consent form. This form outlined the nature of the study, research procedures, the voluntary basis of participation, confidentiality measures, potential risks and benefits, and the use of data for research purposes only. Ensuring informed consent is crucial in adhering to ethical research standards. In the study, informed consent was explained thoroughly to all ESL students. Detailed explanations were provided in both written and verbal formats, and ample opportunity was allowed for students to ask questions to ensure their full understanding. Additionally, accommodations were made to address any language-related challenges, such as of-

fering explanations in simpler language or using a translator if necessary, to ensure that all participants fully comprehended the consent process. The study protocol, including the participant recruitment process and data collection methods, received approval from the Institutional Review Board (IRB) from both Concordia University Texas and The University of Texas at Austin.

## 2.3 Debriefing procedure

Upon completion of the NVRS, each participant underwent a structured debriefing process, which is an integral component of simulation-based learning. This debriefing was designed to enhance learning outcomes and provide support after the immersive VR experience. Facilitated by a team of experienced educators, the debriefing session commenced with participants reflecting on their experiences, articulating their emotional responses, and discussing any challenges encountered during the simulation. The facilitators encouraged open communication to ensure that each student had the opportunity to voice their thoughts and feelings in a supportive environment.

The debriefing aimed to consolidate learning by linking VR experiences with clinical practice, reinforcing the acquisition of knowledge, and emphasizing its application to real-world scenarios. Students were prompted to identify key learning points and discuss how the VR simulation could impact their confidence and competence in clinical settings. Additionally, the debriefing included feedback from facilitators, providing constructive insights into each student's performance and highlighting areas for improvement.

To ensure the debriefing was as effective as possible, a standardized guide based on Kolb's experiential learning theory was followed. This guide ensured that students engaged in reflective observation, enabling them to abstractly conceptualize what they learned and prepare for future active experimentation in clinical practice. The process not only served to solidify the students' learning experiences but also to gauge the efficacy of the NVRS in reducing anxiety and increasing confidence, aligning with the overarching goals of the study.

## 2.4 Data collection

For the initial phase of data collection, we employed an adapted version of a pre-survey, previously utilized in studies involving VR simulations.<sup>[41]</sup> This adaptation was undertaken to ensure that the survey questions were tailored to the specific context of our study and the unique characteristics of our ESL nursing student participants.

The pre-survey (see Table 1) was designed to gather essential baseline data on several key aspects:

- **Geographic Background:** To understand the diverse cultural and geographic origins of the participants, which may influence their experiences and perceptions of VR simulations.
- **Prior VR Experience:** Assessing any previous exposure to VR technology, which could impact their initial comfort

- level and adaptability to the VR simulation used in this study.
- **Comfort in Clinical:** Evaluating participants' self-reported comfort levels in attending traditional clinical courses, providing a benchmark against which changes post-VR simulation can be measured.

**Table 1.** Pre-survey questions

Items	
1) Gender	a) Female b) Male c) Prefer not to answer
2) Age	a) 18-29 b) 30-39 c) 40-49 d) 50+
3) The level of college you are currently enrolled in	a) Junior b) Senior
4) Are you currently enrolled in Nursing program?	a) Yes b) No
5) Are you a native English speaker?	a) Yes b) No
6) What is your primary language?	
7) What is your experience with 3D video games	a) Never b) < 1 per month c) 1-5 per month d) >6 per month
8) Have you participated Virtual Reality (VR) simulation previously?	a) Yes b) No
9) How often are you attending clinical course?	a) Once per week b) 1-3 times per month c) >4 times per month
10) How comfortable are you attending clinical course in hospital?	a) Strongly Agree b) Somewhat Agree c) Neutral d) Somewhat disagree e) Strongly disagree

Previous exposure to VR and clinical settings could have influenced their levels of confidence and anxiety, potentially affecting the study's outcomes. This effect was minimized with a pre-and post-test design. Following the VR simulation experience, participants were required to complete a post-simulation survey. This survey was crucial in evaluating the impact of the VR simulation on the participants' learning experience. It utilized a 5-point Likert scale, enabling participants to express their level of agreement or disagreement with a series of statements pertaining to their VR simulation experience.<sup>[41,42]</sup> The areas assessed in this post-survey (see Table 2) included:

- **Enhanced Learning Experience:** Understanding how participants perceive the effectiveness of VR simulation in enhancing their clinical learning.
- **Reduction in Anxiety:** Measuring any changes in their anxiety levels related to clinical courses post-simulation.
- **Increase in Confidence:** Evaluating the impact of VR experience on their confidence levels in clinical.
- **Overall Satisfaction with VR Simulation:** Gathering feedback on their general satisfaction and any suggestions for improvement.

Both the pre-survey and post-survey were integral in providing a comprehensive understanding of the participants'

backgrounds, experiences, and perceptions. The use of a Likert scale in the post-survey facilitated a nuanced analysis of the participants' responses, allowing for a more precise measurement of the VR simulation's impact.

**Table 2.** Post-survey questions

1) This virtual reality (VR) simulation is easy to participate	a) Strongly agree
	b) Somewhat agree
	c) Neutral
	d) Somewhat disagree
	e) Strongly disagree
2) I was enjoying and satisfied with this VR simulation experience	a) Strongly agree
	b) Somewhat agree
	c) Neutral
	d) Somewhat disagree
	e) Strongly disagree
3) I believe VR simulation can help us increase confidence when we are communicating with patient in hospital	a) Strongly agree
	b) Somewhat agree
	c) Neutral
	d) Somewhat disagree
	e) Strongly disagree
4) I feel this VR simulation is very realistic	a) Strongly agree
	b) Somewhat agree
	c) Neutral
	d) Somewhat disagree
	e) Strongly disagree
5) This VR simulation is an effective tool for understand the experiences	a) Strongly agree
	b) Somewhat agree
	c) Neutral
	d) Somewhat disagree
	e) Strongly disagree
6) I felt immersed in the virtual reality experience	a) Strongly agree
	b) Somewhat agree
	c) Neutral
	d) Somewhat disagree
	e) Strongly disagree
7) I would like to have VR simulation again	a) Strongly agree
	b) Somewhat agree
	c) Neutral
	d) Somewhat disagree
	e) Strongly disagree
8) I strongly recommend the VR simulation	a) Strongly agree
	b) Somewhat agree
	c) Neutral
	d) Somewhat disagree
	e) Strongly disagree

Notes. rating is based on the following scale: strongly agree (5) to strongly disagree (1).

### 3. RESULT

The pre-survey responses reflect the participants’ demographic backgrounds, language proficiency, familiarity with technology, and their comfort and experience levels in clinical settings. Results from the pre-survey show that most participants were identified as female (n = 14, 82%), and other participants identified as male (n = 3, 18%). All participants, except for one who is in the age group 30-39 (n = 1, 6%), fall within the 18-29 age range (n = 16, 94%). Participants are evenly split between Junior (n = 9, 53%) and Senior (n = 8, 47%) college levels.

All participants are non-native English speakers, while Spanish is the predominant primary language (n = 14, 82%), with one participant speaking Arabic, one Tagalog, and one French. Most participants have never played 3D video games (n = 12, 71%), with other participants playing less than once per month (n = 5, 29%), and a minority of participants (n = 3, 18%) have experienced VR simulation previously. Most participants attend clinical courses once per week (n = 10, 59%), with some attending more than four times per month (n = 6, 35%), and one attending 1-3 times per month. Responses indicate varying levels of comfort attending clinical courses in a hospital, with most feeling somewhat comfortable (n = 9, 53%), some neutral (n = 5, 29%), and a few expressing strongly comfort (n = 3, 18%).

It seems that while there is some familiarity with technology such as 3D video games, there is variability in prior VR experience and comfort in clinical courses, which could influence their response to the VR simulation in the study.

By the end of Fall 2023, all the 17 participants had completed at least Session I VR simulation scenarios, and 14 of them finished all the two sessions VR simulation scenarios. Results from the post-simulation surveys indicate that ratings from the 17 prelicensure students regarding their experience were strongly positive (see Table 3). Among the total 31 responses to the post simulation survey questions, for each item on the scale, a majority of the prelicensure students (58%-100%) chose “strongly agree”, and most of the other participants chose “somewhat agree” except for one who chose “neutral” on question 1, “This VR simulation is easy to participate” and two who chose “neutral” on the question, “I feel this VR simulation is very realistic”. None of the participants chose “strongly disagree” or “somewhat disagree”. 97% (30 respondents) either strongly or somewhat agreed that the VR simulation was easy to participate in, with a mean score of 4.55 and a median of 5. Additionally, all students agreed that the VR simulation helped increase their confidence in communicating with patients, with a high perception of realism (94% agreement) and effectiveness as a learning tool (100% agreement). Minimal differences were identified between session I and session II NVRS results.

**Table 3.** Post-survey results

Question	Agreement, % (n)					Median	Mean
	Strongly agree	Somewhat agree	Neutral	Somewhat disagree	Strongly disagree		
1) This virtual reality (VR) simulation is easy to participate	58 (18)	39 (12)	3 (1)	0 (0)	0 (0)	5	4.55
2) I was enjoying and satisfied with this VR simulation experience	94 (29)	6 (2)	0 (0)	0 (0)	0 (0)	5	4.94
3) I believe VR simulation can help us increase confidence when communicating with patient in hospital	90 (28)	10 (3)	0 (0)	0 (0)	0 (0)	5	4.9
4) I feel VR simulation is very realistic	74 (23)	20 (6)	6 (2)	0 (0)	0 (0)	5	4.68
5) VR simulation is an effective tool for understand the experiences	87 (27)	13 (4)	0 (0)	0 (0)	0 (0)	5	4.87
6) I felt immersed in the VR experience	94 (29)	6 (2)	0 (0)	0 (0)	0 (0)	5	4.94
7) I would like to have VR simulation again	94 (29)	6 (2)	0 (0)	0 (0)	0 (0)	5	4.94
8) I strongly recommend the VR simulation	100 (31)	0 (0)	0 (0)	0 (0)	0 (0)	5	5

In summary, students interested in reducing anxiety consented to participation in a VR simulation in nursing school. They initially participated in a basic simulation involving

hospital room orientation and patient assessment. In this process, we have found that immersive experience impressed the students a lot and most students required longer experienc-

ing time. The simulation included voice-guided instructions, which can be repeated as many times as necessary, enhancing their confidence, and leading to successful debriefing participation. Students recommended incorporating VR simulations into the curriculum, especially for junior levels. The VR simulation notably reduced anxiety by allowing independent work. The participants expressed their excitement with this opportunity, during which they were actively answering the interview questions. They also provided their feelings and suggestions for future research on a subsequent, more complex simulation, such as involving a pediatric patient with fever, which could foster critical thinking and require faculty facilitation.

#### 4. DISCUSSION

Results of the pre-survey describe the participants' varied backgrounds and experiences. The preponderance of female participants and the significant representation of young adults within the 18-29 years age bracket mirror trends in current nursing education demographics as discussed by McFarland & Wehbe-Alamah.<sup>[43]</sup> The fact that all participants are non-native English speakers, predominantly Spanish speaking, with varying degrees of comfort in clinical settings, guarantees the study's relevance to ESL nursing student populations.

A key observation from the pre-survey is the limited exposure to 3D video games and virtual reality among participants, which could have influenced their initial engagement with the VR simulations. Despite this, the post-survey results were overwhelmingly positive, suggesting that the NVRS was well received and considered beneficial. This contrasts with Fussell & Truong, who found that familiarity with technology positively influences the acceptance of VR in education.<sup>[44]</sup> This study suggests that even those without prior VR experience can quickly adapt to and appreciate VR in educational settings. The strong agreement that the VR simulation was easy to participate in, enjoyable, and a realistic replication of clinical scenarios is promising. The finding that VR can increase confidence in patient communication aligns with the work of Koukourikos et al., who observed improved communication skills in nursing students using simulation technologies.<sup>[17]</sup> The belief that VR can increase confidence in patient communication and the desire to repeat the simulation experience strengthened the potential of VR as a teaching tool in nursing education. The desire for repeated use of VR simulations supports the findings of Garrett et al., who reported high levels of student engagement and satisfaction with VR in nursing education.<sup>[45]</sup> This study expands on their conclusions by showing continued interest even among those initially unfamiliar with VR technology.

However, the limitations of this study must be acknowledged.

The small sample size and the homogeneity (sex, age, and first language) of the samples limits the generalizability of the findings. The small and homogeneous sample size is a limitation also noted in other educational research, such as the study by Tipton et al. in 2017.<sup>[46]</sup> They emphasized the need for diverse and large samples to enhance the generalizability of findings. Additionally, the trivial differences observed between the two sessions of the study might be attributed to the novelty effect, where initial exposure to a new learning tool may elicit positive responses that do not necessarily persist over time or with repeated exposure. Further, the lack of a control group and the reliance on self-reported measures introduce potential biases that could influence the results.

#### 5. CONCLUSION

This study's findings suggest that NVRS is a promising educational tool that can enhance the learning experiences of ESL nursing students. The pre-survey results provide insight into the baseline technology exposure and comfort levels of the participants, while the post-survey results demonstrate strong positive responses to the VR simulation experience. Most notably, the unanimous recommendation of the VR simulation by participants highlights the perceived value of this modality in nursing education.

Despite the limitations of the study, such as the small and homogeneous sample size and the potential for novelty effects, the results are indicative of the benefits that NVRS can offer. The consistent preference for strong agreement across all survey items suggests that VR simulations are well-suited to meet the educational needs of ESL nursing students, providing immersive, engaging, and realistic experiences that can bolster confidence and clinical communication skills. It is worth pointing out the need for further research with larger, more diverse samples. To build on the foundation established by this study, future assessments with larger, more diverse samples, longitudinal designs, and the inclusion of control groups, as suggested by Baxter & Hainey, are recommended to further explore the efficacy of VR simulations.<sup>[47]</sup> There is a need for more definitive evidence of the long-term benefits and potential integration of VR into nursing curricula, thereby contributing to the development of competent and confident nursing professionals.

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## AUTHORS CONTRIBUTIONS

Prof. Zhong conceived and designed the study, conducted data collection, analysis, and interpretation, drafted the manuscript, and led its revisions. Prof. Champion provided administrative oversight of the study design, technical support for data analysis, and contributed to the manuscript's critical revision. All authors read and approved the final manuscript.

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## DATA SHARING STATEMENT

No additional data are available.

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