Validation of a Virtual Reality Scenario for Surgical Nursing Training

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ABSTRACT:

Introduction: Nursing education requires innovative strategies that promote practical learning in complex clinical contexts. In this scenario, virtual reality emerges as an educational alternative that allows the simulation of safe and dynamic surgical environments, optimizing the acquisition of technical competencies and reducing the risks associated with real clinical practice. Objective: To validate a virtual reality scenario for surgical nursing training in students of the Nursing program. Methods: A quantitative, descriptive, cross-sectional study was conducted. The population consisted of 40 sixth-semester nursing students. Participants interacted with a virtual reality scenario designed for the identification of surgical instruments. Data were collected using the Simulator Sickness Questionnaire (SSQ), the System Usability Scale (SUS), and supplementary questions regarding experience and interest in the use of virtual reality. Data were analyzed using descriptive statistics. Results: Sixty-five percent of the students presented some degree of symptomatology after using the virtual reality scenario, with mild to moderate visual and vestibular symptoms predominating. System usability was highly rated, with an overall acceptance of 93%, indicating a favorable perception of its usefulness and ease of use. Conclusion: The validated virtual reality scenario proved to be a viable and relevant educational tool for surgical nursing training. Despite the presence of immersion-related symptoms, these did not represent a significant limitation for its implementation in the educational process.

Keywords: Virtual reality; Surgical nursing; Nursing education.

Introduction

Nursing education faces the challenge of adapting to a highly technological context, which demands dynamic, interactive and student-centered learning. In this scenario, virtual reality (VR) is presented as an innovative tool that allows the simulation of clinical environments in an interactive and safe way, favoring autonomous and meaningful training in students[1]. Virtual reality is defined as an immersive technology that generates three-dimensional environments simulated by electronic devices, allowing the user to interact with objects and scenarios in a realistic way through vision, sound and, in some cases, touch2.

VR makes it possible to reproduce experiences close to physical reality, facilitating experiential learning and the acquisition of practical skills without risks for the patient. Studies show that VR improves learning, knowledge retention, and student satisfaction by offering clinical training without risk to patients3. VR-based clinical simulation is effective for strengthening the technical and cognitive competencies of nursing students. A systematic review and meta-analysis showed that immersive training significantly improves clinical competence and reduces anxiety in surgical settings4.

In research conducted by Edwards et al.[5] reported that the technical skills of nurse instrumentalists increased from 11% to 84% after immersive knee arthroplasty training, confirming the effectiveness of VR in skill acquisition. In the educational field, VR is used in the teaching of complex procedures, such as monitoring vital signs or managing mechanical ventilation, strengthening self-efficacy, clinical reasoning, and learning satisfaction6-8.

In Latin America, its application is still incipient; however, research carried out in Ecuador highlights that VR favors the development of clinical and technical competencies, generates a positive perception of learning, and strengthens clinical judgment, although it has not yet focused on the validation of specific scenarios for surgical training9,10. The surgical nursing area is complex as it requires the correct identification of surgical instruments, techniques and procedures that allow precise assistance in surgical procedures. However, students face difficulties in developing the required competencies due to the limited availability of real clinical spaces.

The limitations in the practical use of real surgical environments pose the opportunity to create a virtual scenario as an educational strategy that can optimize the training process of nursing students, evaluate the pedagogical usefulness and the acceptance of students. Therefore, it is relevant to analyze the possible physical effects derived from the use of RV11,12.

In this context, the present research seeks to validate a surgical virtual reality scenario with students of the Nursing Career of an Ecuadorian public university, to generate scientific evidence that supports the incorporation of immersive technologies in health education, contributing to educational innovation and the strengthening of clinical competencies in safe and controlled environments13, 14.

Methodology

The research was quantitative, descriptive and cross-sectional, aimed at validating a surgical virtual reality scenario with students of the Nursing Career of an Ecuadorian public university. The study was carried out at an Ecuadorian public university during the academic period September 2025 – August 2026.

The population was made up of students specifically enrolled in the subject of Surgical Nursing, belonging to the sixth semester of the career. The sample was selected using non-probability convenience sampling. The following inclusion criteria were established: students enrolled in the sixth semester who were studying the subject of Surgical Nursing and who gave informed consent. Those who manifested visual, neurological or vestibular alterations that could interfere with the use of virtual reality were excluded, as well as those students who were not present on the day of data collection or withdrew their consent.

Participants had to interact with the surgical virtual reality scenario designed for the identification of surgical instruments and, subsequently, they answered a structured questionnaire in digital format. The instrument was composed of three main sections: the Simulator Sickness Questionnaire (SSQ), validated in Spanish by Campo-Prieto et [11], used to measure physical symptoms such as nausea, dizziness, disorientation, and visual fatigue; the System Usability Scale (SUS), validated in Spanish by Castilla et al. (2023)[12], used to evaluate the usability of the virtual environment; and supplemental questions designed to inquire about previous experience with VR. The data were collected through self-administered forms in Google Forms with an estimated application time of 30 minutes. Subsequently, the information was

exported to Excel and processed in the SPSS version 15 statistical software, using descriptive analysis of frequencies and percentages.

The ethical aspects considered in the research were developed in accordance with the principles established in the Declaration of Helsinki and the Human Research Ethics Committee (CEISH – UTA) with code 188-CEISH-UTA-2025, with an approval date of December 1, 2025. Participation was voluntary, the informed consent of all students was requested and the confidentiality of the data, respect for the dignity and the right of the participants to withdraw at any time were guaranteed.

Results

The analysis of sociodemographic data (Table 1) shows that the predominant age group corresponds to students from 22 to 23 years old, with 34 (85%) participants, while the ranges from 20 to 21 years old and 24 to 25 years old registered only 3 (7.5%) students each. Regarding gender, 34 (85%) participants were women and 6 (15%) men, which confirms the marked female presence characteristic of the Nursing career. Regarding the academic parallel, 22 (55%) students belonged to parallel A and 18 (45%) to parallel B, showing a balanced distribution between both groups.

Table 1. Sociodemographic data

Criteria		Frequency	%
Age	20-21 years	3	7,5
	22-23 years old	34	85
	24-25 years	3	7,5
Sex	Women	34	85
	Men	6	15
Parallel	A	22	55
	B	18	45

Source: Instrument applied by Llerena

Own elaboration.

Symptoms presented by nursing students in the use of the surgical virtual reality scenario

The present analysis describes the symptoms reported by 40 nursing students after their exposure to a surgical virtual reality scenario, taking as a reference questions 2 to 8 of the Simulator Sickness Questionnaire (SSQ). The results show that 14 (35%) students did not present symptoms, while 26 (65%) reported some degree of involvement, distributed in mild symptoms 6 (15%), moderate 13 (32.5%) and severe 7 (17.5%). These values indicate that more than half of the participants experienced discomfort after using virtual reality.

Regarding visual symptoms, a greater symptom burden was identified. Difficulty focusing had a mean of 1.13, eyestrain 1.10, blurred vision 1.03 and visual fatigue 1.05. Visual discomfort was one of the most frequent symptoms, reported by 23 (57.5%) students at different levels of intensity. These data suggest an overload of the visual system, possibly associated with exertion and prolonged exposure to three-dimensional stimuli.

In the vestibular setting, dizziness was the symptom with the highest average severity (mean = 1.30), affecting 55% of the students, with 12.5% at a moderate level and 5% at intensities ranging from very intense to extreme. Postural instability, although less frequent (45%), presented extreme cases in 5% of the sample.

On the other hand, gastrointestinal symptoms show a noticeably lower frequency and severity. Nausea, reported by 40% of participants, registered an average of 0.95, with only 7.5% of cases described as severe. Symptoms such as belching and increased salivation had the lowest means (0.28 and 0.33, respectively), with more than 75% of students indicating absence. This suggests that, in this population, the gastrointestinal autonomic response does not constitute the main axis of post-exposure symptomatology.

Finally, in the cognitive-perceptual dimension, difficulty concentrating was reported by 60% of the participants, while disorientation affected 30%, mainly at mild to moderate levels. The presence of these symptoms could be related to the cognitive load imposed by interaction in a novel environment.

When analyzing the level of symptoms (Table 2.), the following were evident: 14 (35%) students were absent, 13 (32) moderate, 7 (18%) severe, and 6 (15%) mild.

Table 2. Symptom levels

Levels	N	%
Absent	14	35
Mild	6	15
Moderate	13	32
Serious	7	18

Source: Instrument applied by Llerena

Own elaboration.

Use of the surgical virtual reality scenario by students

Regarding prior knowledge and access to technology (Table 3), the results showed an equal distribution: 50% of the students said they knew about virtual reality (VR), while the other half said they had no prior knowledge. However, only 6 students (15%) of participants had a VR device in their home, suggesting that while half are familiar with the concept, personal access to the technology is limited.

In terms of VR use and experience, most students reported low VR use (42.5% "not at all" and 35% "little"), with a mean of 1.90 on a scale that could be interpreted from 1 to 5. Regarding familiarity, 50% considered themselves "little" familiar (mean = 2.48). However, the high interest in technology stands out, 32.5% expressed interest "frequently" and 17.5% "very frequently", with an average of 3.33. This reveals a favorable motivation towards VR.

Table 3. Use of the surgical virtual reality scenario by students

Categories Options		Frequency	%
Using VR	Nothing	17	42,5
	Little	14	35
	Sometimes	6	15
	Frequently	2	5
	Very common	1	2,5
Familiarity with VR	Nothing	4	10
	Little	20	50

	Sometimes	11	27,5
	Frequently	3	7,5
	Very common	2	5
Interest in VR	Nothing	3	7,5
	Little	8	20
	Sometimes	9	22,5
	Frequently	13	32,5
	Very common	7	17,5

Source: Instrument applied by Llerena

Own elaboration

In the evaluation of the immersive experience (Table 4), the students positively valued the interaction with the surgical scenario in VR, with an overall mean of 3.15. The best evaluated aspects were ideal interactivity (mean = 3.13), dynamic environment (mean = 3.13) and stage movement (mean = 3.10). Visual accuracy (2.95) and action-system coherence (2.90) received slightly lower, though still positive, scores. Auditory feedback was the aspect with the lowest mean (2.75), which could indicate an area of improvement in the sound design of the simulator.

Regarding the usability of the interface and navigation, the students rated the home page favorably (overall mean = 3.05), highlighting the clarity of the icons (mean = 3.05), visibility of the main options (mean = 3.03) and organization of titles (mean = 3.03). Regarding the experience with the VR glasses and navigation, 85% of the students "agree" or "strongly agree" that the experience was positive (overall mean = 4.20 on the agreement scale). The ease of use of the glasses obtained 85% acceptance (mean = 4.10), and intuitive navigation 81% (mean = 3.98).

In relation to educational relevance, 83% of the students agreed that the contents presented corresponded to Surgical Nursing (mean = 4.00), and 75% considered that the identification of the instruments was adequate (mean = 3.88). These results reinforce the content validity of the simulator for nursing training.

Regarding the intention of future use and recommendation, a very favorable attitude was observed with 81% who expressed interest in using VR again (mean = 4.33), 71% probability of using it to learn (mean = 4.13) and 78% would recommend its use in teaching (mean = 4.23). The willingness to buy devices was lower (63%, mean = 3.88), which may be associated with economic limitations rather than lack of interest.

Finally, in the overall usability evaluation, 93% of students rated the system positively ("agree" or "strongly agree"), with an overall average of 4.67. Ease of use (100% agreement, mean = 5.00), perceived safety (95%, mean = 4.85) and ease of learning for others (100%, mean = 5.00) stand out. These data reflect high perceived usability and a satisfactory user experience, despite the symptoms reported in the SSQ.

Nursing students, despite having limited access to VR devices and little previous experience, showed high interest and a mostly positive perception towards the VR surgical simulator. The experience was rated as immersive, usable and relevant to their training, with a clear intention of reuse and recommendation. These findings support the educational viability of VR in surgical nursing, although it is suggested to optimize aspects such as auditory feedback and consider strategies to reduce the symptoms reported in the present research in order to maximize student acceptance and potential nursing training.

Table 4. Immersive Experience Evaluation

		Statisticians					
		Icons Startup Information	Ease of Access	Visible main options	Titles Content Summary	Titles do not exceed 7 words	Repeated menu on all pages
N	Valid	40	40	40	40	40	40
	Lost	0	0	0	0	0	0
	Media	3,05	2,93	3,03	3,03	2,88	2,68

Source: Instrument applied by Llerena

Own elaboration

Discussion

The results of the present study show that the use of the surgical virtual reality scenario produced a combination of high usability and moderate presence of symptoms associated with VR immersion. In this study, 65% of the students presented some degree of symptomatology according to the SSQ, with visual and vestibular symptoms predominating, a trend consistent with what was described by Saab et al. (2023)[15], who also observed mild to moderate symptoms during simulation experiences in nursing students. Similarly, Rubio-López et al. (2025)[16] reported that advanced simulations tend to generate high visual load, eye fatigue, and difficulties in focusing, which coincides with our findings where visual symptoms showed the highest means (between 1.03 and 1.13). Campo-Prieto et al. (2022)[11] complement this trend by pointing out that visual overload is one of the most common effects even in users with low technological familiarity.

In the present study, vestibular symptoms were the most frequent, with a mean of 1.30 and present in 55% of the students, a pattern similar to that reported by Rubio-López et al. (2025)[16], who described moderate levels of dizziness in high-immersion clinical simulations. In a related way, Abu Selo et al. (2025)[17] showed that exposure to dynamic virtual environments significantly increases visuo-vestibular discomfort, especially when visual movement does not coincide with real body movement. The results obtained are related to what was stated by Keshavarz et al. (2025)[18], who demonstrated that eye strain and other visual symptoms increase in susceptible users when immersive stimulation is intense or prolonged.

Gastrointestinal symptoms were the least frequent and least intense, with means below 1, suggesting that the autonomic response does not constitute a relevant barrier to the educational use of VR. This is consistent with Saab et al. (2023)[15], who reported low nausea in students exposed to short-term simulations, indicating that limiting the exposure time can significantly reduce this type of discomfort.

Despite the fact that only 15% of participants had a VR device and that most reported little prior experience, the overall perception of the technology was highly positive. This coincides with Campo-Prieto et al. (2022)[11], who observed that even users with little technological familiarity show motivation and interest in immersive experiences due to their innovative and attractive nature. In this study, students showed a high interest in continuing to use the technology, reflecting a growing acceptance of VR as a learning tool.

The immersive experience was evaluated favorably, especially in terms of interactivity. However, auditory feedback received the lowest rating, which is consistent with the observations of Abu Selo et al. (2025)[17], who state that audiovisual sensory coherence is essential to reduce immersive discomfort and improve the

sense of presence. This aspect represents an area of opportunity to improve the design of the designed surgical environment.

Usability was one of the highlights of the study. Students rated ease of use, perceived safety, and ease of learning with averages greater than 4.8, results that exceed those reported by Saab et al. (2023)[15] in VR-based nursing simulations. This also coincides with what was described by Choi et al. (2022)[19], who found that simulators with intuitive design and integrated guidance significantly raise the perception of usability and user satisfaction. In this study, clear navigation and intuitive interface contributed to the high level of acceptance.

Educational relevance obtained high values (83%), showing that students considered the clinical content of the VR surgical scenario to be adequate. This result is consistent with what has been reported in various studies that highlight that VR improves the understanding of clinical procedures, facilitates safe practice, and promotes student motivation19. Intention for future use was also high, with more than 80% of students willing to reuse the technology or recommend it, evidencing its potential as an innovative educational resource.

Overall, the results of this study recognize virtual reality as an effective, motivating and well-accepted training tool for health sciences students. Although visual and vestibular symptoms persist, their intensity was predominantly moderate and coincides with the patterns described in previous research. These symptoms can be minimized through technical optimizations, improvements in visual quality, adjustments in exposure times, and a more balanced sensory design. Finally, the combination of high usability, high acceptance, and educational relevance supports the incorporation of VR in surgical nursing education, with the need to continue researching strategies to reduce the discomfort associated with immersion and ensure more comfortable and effective learning experiences.

Proposal of an Educational Strategy to Incorporate The Surgical Virtual Reality Scenario In Nursing Training

The purpose of this strategy is to strengthen the competencies of Surgical Nursing students through the use of a virtual reality scenario, mainly aimed at the identification of surgical instruments and safe participation within the operating team. The proposal is based on the results obtained in this study, where students expressed a high acceptance of the virtual environment, adequate usability and disposition for its future use, so the integration of this tool represents an innovative and relevant pedagogical alternative for clinical learning.

Theoretical models that support the proposal: Experiential Learning (David Kolb), Situated Learning Theory (Lave and Wender) and Constructivism Theory (Jean Piaget).

Competencies to be developed: identification of surgical instruments, clinical reasoning and decision-making in a simulated environment, teamwork within the surgical environment and attitudes towards safety, confidence and motivation in clinical practice.

Strategy implementation phases

- Theoretical induction and preparation: involves safety rules, surgical team roles, and instructions.
- Guided interaction in the virtual environment: Explore the surgical scenario.
- Immersive autonomous practice: identification of instruments, application of knowledge and development of skills.
- Formative feedback: analysis of the student's performance.
- Reinforcement and programmed repetition: A second practice is carried out. Optimize performance, improve accuracy, and reduce symptoms.

Required Resources

- Virtual reality headsets and controllers.
- Interactive surgical virtual scenario.

- Safe physical space for simulation.
- Teacher facilitator trained in educational technology.
- Instructional guide for the student.

Evaluation of learning

Performance rubrics.

Conclusion

The validation of the virtual reality scenario showed that this tool constitutes an effective educational alternative for the development of competencies in Surgical Nursing, especially in the identification of instruments and the understanding of the operating environment. Although most students had little previous experience with technology, usability, ease of navigation, and relevance of content were widely valued.

Although mild to moderate visual and vestibular symptoms were identified, these do not represent a significant limitation for the use of the simulator. This type of discomfort usually appears during the first immersive experiences and can decrease significantly when exposure times are controlled, the student is properly oriented and the visual stability of the environment is optimized. With these improvements, symptoms tend to be minimal, allowing the tool to maintain its training function safely, comfortably, and effectively.

The results show that virtual reality is a viable, motivating and well-accepted technology for clinical training, with a high potential to be formally integrated into the teaching of Surgical Nursing. It is recommended to strengthen the visual and auditory aspects of the simulator, as well as to promote teacher and student training in its use, in order to maximize the educational impact and guarantee more comfortable and productive immersive experiences.

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