

Immersive Virtual Reality Simulation for Preeclampsia in Undergraduate Nursing Education: A Descriptive Mixed-Methods Evaluation

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Abstract

Background: Immersive virtual reality (VR) offers nursing students a standardized environment in which to apply knowledge and practice clinical decision-making without risk to patients.

Purpose: This study described nursing students' knowledge, anxiety, self-confidence, and perceptions following an immersive VR simulation focused on the care of a patient with preeclampsia.

Methods: A descriptive mixed-methods evaluation was conducted with 60 prelicensure Bachelor of Science in Nursing students at a public university. An immersive VR module was incorporated into an existing obstetrical nursing curriculum. Anxiety and self-confidence were assessed using the Nursing Anxiety and Self-Confidence with Clinical Decision-Making Scale. Students' perceptions were collected using the Clinical Completion Questionnaire and open-ended responses.

Results: Most participants were female (76.9%), were 24 years of age or younger (84.6%), and had no previous immersive VR experience (69.2%). Students reported relatively high self-confidence in clinical decision-making ($M = 4.63$, $SD = 0.42$, on a six-point scale) and low-to-moderate anxiety ($M = 2.38$, $SD = 0.75$, on a six-point scale). The overall simulation evaluation was favorable ($M = 2.60$, $SD = 0.31$, on a three-point scale). Debriefing received the strongest evaluation ($M = 2.91$, $SD = 0.28$), followed by learning and confidence outcomes ($M = 2.52$, $SD = 0.41$) and prebriefing ($M = 2.35$, $SD = 0.52$). The measures demonstrated good-to-excellent internal consistency (Cronbach's $\alpha = .82-.97$). Qualitative findings emphasized realism and opportunities to practice clinical decision-making and emergency management. Students recommended additional orientation and reported challenges with navigation, equipment, and access to supplies.

Conclusion: Immersive VR was perceived as an engaging and psychologically safe alternative clinical learning experience when direct exposure was unavailable or inconsistent. A structured technology orientation, navigation practice, and facilitated debriefing may strengthen its educational value, although VR should complement rather than replace hands-on learning.

Keywords: clinical judgment, immersive virtual reality, nursing education, obstetrical nursing, simulation

1. Introduction and Background

Preparing nursing students to make timely, safe clinical decisions requires more than knowledge of isolated signs and interventions. Students must recognize relevant cues, interpret findings, establish priorities, communicate effectively, and select appropriate nursing actions. Opportunities to develop these abilities are not always consistent across clinical placements, particularly for uncommon or rapidly evolving obstetrical emergencies. This variability creates a need for structured alternative clinical learning experiences in which students can apply knowledge without placing patients at risk.

Immersive virtual reality (VR) simulation offers one approach to addressing this need. Using a head-mounted display and interactive controllers, students enter a three-dimensional clinical environment, assume the nurse's role, assess a virtual patient, and respond to changes in the patient's condition. The combination of immersion, presence, and interactivity can create a strong sense of participation in the simulated encounter (Birkhead et al., 2019; Radianti et al., 2020). Unlike observation-based learning, immersive VR requires the learner to make

decisions and experience the consequences of those decisions within a standardized scenario (Verkuyl et al., 2017).

The educational value of immersive VR may be especially relevant in obstetrical nursing. Preeclampsia requires prompt recognition of multisystem findings, careful prioritization, seizure precautions, medication monitoring, and preparation for escalating care. Yet students may have limited opportunities to participate actively in the care of a patient with this condition during clinical placement. A virtual scenario can provide an alternative clinical experience when direct exposure to such a high-risk event is unavailable or inconsistent. Within this psychologically safe environment, students can practice assessment, communication, clinical judgment, and intervention. Repetition, feedback, and debriefing can further support reflection and refinement of performance (Koivisto et al., 2016, 2018).

Evidence suggests that immersive VR can support nursing students' knowledge, skills, self-confidence, satisfaction, and engagement, although outcomes vary by technology, scenario design, learner preparation, and comparison condition (Choi et al., 2022; Liu et al., 2023; Quah et al., 2025). Technical unfamiliarity and the absence of tactile practice may also limit learning if students must divide their attention between navigating the system and reasoning through the clinical problem (George & Titus, 2024). Consequently, evaluation should consider not only knowledge outcomes but also students' confidence, anxiety, perceptions of preparedness, and experiences of the instructional design.

This study addressed that need by describing undergraduate nursing students' knowledge of preeclampsia, anxiety and self-confidence in clinical decision-making, and perceptions of an immersive VR simulation integrated into an obstetrical nursing curriculum. The evaluation also explored which features supported learning and which aspects required improvement.

2. Method

2.1 Design and Setting

This study used a descriptive mixed-methods design comprising descriptive quantitative and descriptive qualitative components. An immersive VR simulation module was integrated into an existing undergraduate obstetrical nursing course at a public university. Quantitative data described students' knowledge, anxiety, self-confidence, and perceptions of the learning experience. Qualitative data from open-ended responses provided further insight into students' experiences with the simulation.

2.2 Participants

Participants were 52 students enrolled in a traditional, prelicensure Bachelor of Science in Nursing program. Most participants were female (76.9%), were 24 years of age or younger (84.6%), and had not previously participated in an immersive virtual simulation (69.2%). The immersive VR simulation was integrated into course instruction; participation in the research component was voluntary.

2.3 Immersive VR Simulation

The simulation was delivered using the immersive virtual reality (IVR) platform developed by Oxford Medical Simulation (OMS, n.d.). Students used a head-mounted display and handheld controllers to enter and interact with a three-dimensional clinical environment. From the nurse's perspective, students assessed a virtual patient, interpreted clinical information, made clinical decisions, and implemented nursing interventions.

The scenario was aligned with the Next Generation NCLEX-RN Test Plan, the National Council of State Boards of Nursing Clinical Judgment Measurement Model, and *The Essentials: Core Competencies for Professional Nursing Education* (American Association of Colleges of Nursing [AACN], 2021; National Council of State Boards of Nursing [NCSBN], 2023). The experience incorporated prebriefing, participation in the immersive scenario, feedback, and structured debriefing consistent with the Healthcare Simulation Standards of Best Practice (INACSL Standards Committee, 2021).

2.4 Data Collection

Students completed questionnaires addressing knowledge of the clinical situation, anxiety and self-confidence in clinical decision-making, and perceptions of the simulation experience. Anxiety and self-confidence were assessed using the Nursing Anxiety and Self-Confidence with Clinical Decision Making Scale (NASC-CDM). The Clinical Completion Questionnaire included items addressing preparedness and the simulation experience, as well as opportunities for written comments. Closed-ended items generated quantitative data, and open-ended responses generated qualitative data. Students participated in prebriefing before entering the immersive scenario and in facilitated debriefing after the experience.

2.5 Measures

Knowledge questionnaires focused on the recognition and management of preeclampsia. Anxiety and self-confidence in clinical decision-making were assessed with the 27-item, six-point Likert-type NASC-CDM, which contains separate anxiety and self-confidence subscales (White, 2014). Students' perceptions were assessed using the Clinical Completion Questionnaire.

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The outcomes of interest were students' anxiety and self-confidence in clinical decision-making, knowledge of preeclampsia, perceptions of preparedness for clinical care, and descriptions of the immersive VR learning experience.

2.6 Ethical Considerations

Approval was obtained from the university's institutional review board before data collection. Students were informed that research participation was voluntary and that their decision to participate or decline would not affect their grades or academic standing. Participant information was maintained confidentially, and findings were reported in aggregate form.

3. Results

3.1 Participants

The study included 52 prelicensure BSN students enrolled at a public university. Most participants were female (76.9%), were 24 years of age or younger (84.6%), and had no previous experience with immersive VR (69.2%).

3.2 Self-Confidence and Anxiety in Clinical Decision-Making

Students reported relatively high self-confidence in clinical decision-making ($M = 4.63$, $SD = 0.42$, on a six-point scale) and low-to-moderate anxiety ($M = 2.38$, $SD = 0.75$, on a six-point scale). The self-confidence and anxiety subscales demonstrated excellent internal consistency, with Cronbach's alpha values of .91 and .97, respectively. Students were most confident when gathering information, communicating with patients, using active listening, and recognizing when assistance from an instructor or staff nurse was needed. They reported lower confidence and greater anxiety when independently establishing priorities, making clinical decisions, and selecting appropriate interventions.

3.3 Perceptions of Clinical Learning

The overall simulation evaluation was favorable ($M = 2.60$, $SD = 0.31$, on a three-point scale) and demonstrated good internal consistency (Cronbach's $\alpha = .89$). Debriefing received the strongest evaluation ($M = 2.91$, $SD = 0.28$; $\alpha = .96$), followed by learning and confidence outcomes ($M = 2.52$, $SD = 0.41$; $\alpha = .89$) and prebriefing ($M = 2.35$, $SD = 0.52$; $\alpha = .82$). Students reported that the simulation supported assessment, prioritization, communication, clinical decision-making, and safe nursing care. Debriefing was especially valued for promoting self-reflection and providing constructive feedback. The comparatively lower prebriefing score was consistent with students' recommendations for additional preparation and technology orientation before entering the virtual environment.

3.4 Knowledge Related to Preeclampsia

Knowledge responses demonstrated a strong understanding of several essential concepts. Students generally recognized hypertension, visual changes, epigastric or right upper-quadrant pain, oliguria, hyperreflexia, clonus, and respiratory changes as important findings. They also demonstrated knowledge of seizure precautions, HELLP syndrome, magnesium sulfate therapy, magnesium toxicity, renal monitoring, and immediate care during an eclamptic seizure.

Several areas required further reinforcement. Students demonstrated uncertainty regarding delivery as the definitive treatment for preeclampsia, laboratory studies associated with hepatic involvement and HELLP syndrome, fluid management to reduce the risk of pulmonary edema, and appropriate care for thrombocytopenia. Responses to select-all-that-apply items also suggested that some students recognized the primary intervention but did not consistently identify all relevant assessment findings or nursing actions. These patterns indicate a need for additional instruction on the multisystem complications of preeclampsia and the integration of assessment findings, laboratory results, and nursing priorities.

3.5 Student Perceptions of the Immersive VR Experience

The qualitative responses reinforced the educational value of immersive VR. Recurring patterns concerned realism and engagement, independent clinical decision-making, psychological safety, debriefing and preparation,

and technology-related limitations.

3.5.1 Realism, Engagement, and Clinical Responsibility

Students described the simulation as realistic, engaging, enjoyable, and beneficial for developing clinical judgment. Many reported that the experience enabled them to feel like the nurse responsible for the patient's care. The opportunity to make decisions independently encouraged them to prioritize interventions, apply classroom knowledge, and assume greater responsibility for patient outcomes.

3.5.2 Psychological Safety

Students valued being able to make decisions, explore different actions, and learn from mistakes without feeling watched or judged. This reduced-pressure environment appeared to support confidence, autonomy, and active participation.

3.5.3 Preparation, Technology, and Tactile Practice

The most frequently identified limitation was unfamiliarity with the technology. Students described difficulty navigating the virtual environment, locating equipment, and understanding the controls. Several indicated that the scenario ended just as they were becoming comfortable with the system. They recommended a structured orientation, guided tour, or practice session before beginning the clinical scenario. Some students also noted that VR lacked the physical, hands-on component of manikin-based simulation. Although they valued immersive VR, they did not consistently view it as a replacement for traditional simulation.

4. Discussion

This descriptive mixed-methods evaluation suggests that immersive VR provided students with a positive and engaging obstetrical nursing learning experience. Students reported confidence in information gathering and communication but greater uncertainty when interpreting findings, establishing priorities, and acting independently. Their responses also showed substantial knowledge of preeclampsia alongside specific gaps involving definitive treatment, laboratory interpretation, fluid management, thrombocytopenia, and comprehensive responses to complex questions. Together, the findings support immersive VR as a supplemental strategy for developing clinical judgment while identifying content and instructional needs for future implementation.

4.1 Student Satisfaction and Engagement

Students described the immersive simulation as realistic, enjoyable, and engaging. Assuming the nurse's role and accepting responsibility for the virtual patient's care encouraged active participation and application of classroom knowledge. These findings are consistent with research reporting favorable effects of immersive VR on nursing students' satisfaction, engagement, and clinical learning experiences (Bradley et al., 2024; Choi et al., 2022; Quah et al., 2025). The scenario offered a meaningful context in which students could recognize cues, analyze information, establish priorities, and respond to a patient's changing condition.

4.2 Self-Confidence, Anxiety, and Clinical Judgment

The item-level pattern provides a more nuanced interpretation than an overall confidence score alone. Students appeared comfortable gathering information and communicating but less assured when synthesizing findings into priorities and interventions. This distinction is educationally important because clinical judgment requires progression from cue recognition to interpretation and action. Faculty can use the identified knowledge gaps and lower-confidence domains to target follow-up instruction, guided reasoning, and repeated practice. Because the available data did not permit matched pretest-posttest comparisons, these findings describe students' reported experience and should not be interpreted as evidence that the simulation caused changes in confidence, anxiety, or knowledge.

4.3 Psychologically Safe Learning Environment

Students valued the opportunity to make decisions, explore alternatives, and learn from errors without causing patient harm or feeling judged. This psychological safety appeared to support autonomy and active participation. Standardized practice in a controlled environment is a frequently identified benefit of VR simulation (Kiegaldie & Shaw, 2023; Liu et al., 2023). Psychological safety should nevertheless be intentionally supported through clear expectations, faculty availability, and structured reflection (INACSL Standards Committee, 2021).

4.4 Prebriefing and Debriefing

Debriefing was one of the strongest instructional components reported by students. Its perceived contribution to reflection, clinical judgment, and constructive performance review supports the continued use of facilitated

debriefing after immersive scenarios. In contrast, students' less favorable views of prebriefing and requests for more preparation indicate that the preparatory phase requires strengthening. Purposeful prebriefing should clarify objectives, orient students to the environment, explain available resources, and establish expectations before clinical decision-making begins (INACSL Standards Committee, 2021).

4.5 Technology Considerations

Technological unfamiliarity reduced students' ability to engage fully at the beginning of the scenario. Difficulty navigating, locating equipment, and using controls consumed attention that could otherwise have been directed toward clinical reasoning. Similar usability and physical barriers have been reported in reviews of immersive VR education (George & Titus, 2024; Quah et al., 2025). A guided tour and low-stakes practice session should therefore precede the clinical scenario. The absence of tactile practice also limits the modality for objectives requiring psychomotor skill performance. Immersive VR is consequently best positioned as a complement to manikin-based simulation and direct clinical experience rather than as a replacement for them.

4.6 Implications for Nursing Education

The findings support incorporating immersive VR into undergraduate nursing curricula as an alternative clinical learning experience when appropriate direct-care opportunities are unavailable and as one component of a broader simulation strategy. Faculty should align scenarios with course outcomes, provide a comprehensive orientation, allow students to practice navigation before the graded or clinically focused experience, and retain facilitated debriefing. The findings also identify content for focused remediation, including the multisystem effects of preeclampsia, interpretation of laboratory findings, fluid management, thrombocytopenia, and integration of multiple assessment cues and nursing actions. Repeated or refresher experiences may be useful, although additional research is needed to determine optimal frequency and durability of learning (Liu et al., 2023; Quah et al., 2025).

4.7 Limitations

Several limitations should be considered. The sample was drawn from one prelicensure BSN program at a public university, limiting transferability to other settings. Anxiety, self-confidence, and perceptions were self-reported and may be subject to response bias. The evaluation did not establish long-term knowledge retention or transfer to clinical performance. Finally, differences in prior familiarity with VR may have influenced students' experiences.

4.8 Recommendations for Future Research

Larger and more diverse samples, comparison groups, and randomized designs should be considered when feasible. Longitudinal research is needed to examine retention and transfer to clinical performance. Research should also compare immersive VR with manikin-based and blended simulation, evaluate the effect of technology orientation and repeated exposure, assess cost-effectiveness, and identify strategies that improve accessibility and comfort.

5. Conclusion

Immersive VR provided undergraduate nursing students with an engaging and psychologically safe environment in which to apply knowledge of preeclampsia, practice prioritization, and assume responsibility for patient-care decisions. Students reported confidence in gathering information and communicating but remained less certain when interpreting findings and acting independently. Realism, autonomous decision-making, and debriefing were major strengths; technological unfamiliarity and the absence of tactile practice were the principal challenges. Immersive VR may provide a valuable alternative experience when direct clinical exposure is unavailable or inconsistent, but it is most appropriately used as a complement to manikin-based simulation and hands-on clinical learning.

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