BMC Nursing

RESEARCH Open Access

Nursing experience with pneumonia patients based on visual reality simulation: a qualitative study

Soomin An[1] and Youn-Joo Um[1*]

Abstract

Background Clinical experience is crucial for nursing students. However, opportunities for hands-on care, especially in complex conditions such as pneumonia, are limited. Virtual reality (VR) offers a solution simulating real-world patient care scenarios. This study explored nursing students' experiences and perceptions of using virtual reality (VR) in the nursing care of patients with pneumonia. It sought to identify the benefits and challenges of integrating VR into nursing education to enhance clinical competencies in managing pneumonia. Additionally, it provides recommendations for improving nursing education to ensure that future nurses gain sufficient experience in caring for patients with pneumonia.

Methods This qualitative descriptive study involved 48 nursing students from a Regional university in Korea. Data were collected in December 2023 through reflection journals completed by participants; these journals were analyzed using thematic content analysis.

Results The analysis identified 10 subtopics, including four themes: (1) enhancing nursing skills for patients with pneumonia; (2) improving nursing communication skills; (3) creating a learning environment using VR technology; and (4) increasing awareness of nursing capabilities through VR.

Conclusion By using VR, nursing students experienced a series of scenarios involving caring for patients with pneumonia. More diverse VR scenario developments and technical improvements are needed to enhance the competencies of prospective nurses.

Keywords Qualitative, Visual reality, Nursing, Pneumonia

*Correspondence:
Youn-Joo Um
digimong8333@gmail.com
[1]Department of Nursing, Dong-Yang University, 145 DongyangDaero, Punggi, Yeongju, Gyeongbuk 36040, Republic of Korea

Background

The motivation to learn is a key factor in determining learners' success in classroom settings. The expectancy-value theory of motivation proposes that learner motivation comprises two components [1]. Learners must believe that learning is important or valuable and have reasonable expectations of success [2]. There has been growing interest in developing educational strategies that target these intrinsic and extrinsic factors to increase learner motivation. One strategy that targets learner motivation is virtual reality (VR) simulation. Learning through VR simulations can motivate students because of its interactive and immersive features [3].

The development of technology has brought about various changes in daily life, and virtual reality (VR) stands out as an area that has undergone significant transformation and is recognized as an important technology in the era of the 4th Industrial Revolution. VR has been recognized for its potential applications in various fields, particularly education. Previous studies have shown that the use of VR in educational settings fosters high levels of student immersion and engagement, leading to improved learning outcomes [4]. Specifically, interactivity and immersion allow students to feel like they are present in the virtual world, engaging in learning as intended [5]. These characteristics have caused the interest in developing VR-based educational content across diverse academic disciplines.

In the healthcare field, VR technology has been actively integrated to offer immersive experiences for training professionals, especially in areas such as nursing, where realistic simulations of patient care scenarios can enhance skill development [6]. The growing exploration of VR in nursing education, particularly for training to manage different conditions, including pneumonia, for training in the management of conditions, highlights its potential to improve both practical learning and patient care.

Pneumonia is an inflammation of the lungs caused by infection with microorganisms, such as bacteria, viruses, and fungi. The initial symptoms are similar to those of a cold, such as coughing and phlegm. However, if breathing becomes difficult, accompanied by high fever or abnormal breathing sounds, an accurate diagnosis of pneumonia and appropriate treatment are required [7]. Pneumonia has consistently been one of the leading causes of death, as reflected in the 2020 Korean cause of death statistics [8]. The pneumonia mortality rate increased significantly from 1998 to 2018, and the age-standardized pneumonia mortality rate increased by an average of 4.15 individuals per year over that time. The possibility of COVID-19 infection progressing to pneumonia has caused the mortality rate to increase, emphasizing the importance of nursing patients with pneumonia. Therefore, it is essential to offer nursing students education that integrates both practical experience and theoretical knowledge in caring for patients with pneumonia.

Simulation-based education has been recognized as a valuable method for overcoming the limitations of traditional observation-based learning. It has garnered attention because it can replicate various situations, including those that are not frequently encountered in clinical practice [9]. In particular, with recent advancements in the educational environment, such as the utilization of social media, Internet media technology, and communication technology, simulation education utilizing virtual reality has enhanced student immersion and demonstrated educational effectiveness [10], VR simulation has been shown to offer a higher level of interactivity and realism than traditional methods, allowing for the design of diverse and complex scenarios [11]. It also enhances learners' critical thinking skills by presenting vivid scenarios that facilitate improved information retention. Moreover, it positively affects engagement, participation rates, and confidence in the curriculum, thereby helping learners achieve their learning goals. By experiencing a sense of presence in a virtual world that mimics reality [12], learners can immerse themselves in the role of the main character in the video and foster empathy by experiencing the character's emotions [13]. This aspect contributes significantly to the learning process.

When analyzing the research on the application of nursing-related VR simulation programs conducted thus far, it is apparent that the focus of application research has been on basic nursing skills. Studies have reported improvements in nursing performance as a result of the repeated practice of these skills [14–16].

Recent studies have attempted to enhance nursing competency by applying complex nursing skills and a series of nursing processes to patients with health problems [17–19]. Building on this research, this study investigated nursing students' practical experiences of caring for patients with pneumonia through VR. In the future, we intend to use this exploration to enhance VR-based pneumonia patient education and programs.

Methods

Research design

This study employed a qualitative descriptive design that utilized reflective journals [20]. Reflective journal data were analyzed using qualitative content analysis [21]. Qualitative research, as a systematic and subjective approach, increases the insight, understanding, and awareness of human experience. Descriptive qualitative research was used as it is based on the general premise of constructivist inquiry and assumes a naturalistic perspective. This design is used to investigate healthcare- and

nursing-related phenomena [22]. Qualitative descriptions provide a direct account of the phenomenon under study and remain close to participants' perspectives and interpretations in a specific space and time. This research design is suitable for research questions that focus on who, what, and where of an event or experience and gain insight into a phenomenon that is not well understood by informants [22]. Therefore, this method seemed well suited to the data collection method utilized and helped nursing students recognize and express their experiences in a VR simulation classroom on pneumonia care. The participants used a Korean-language VR program that provided all dialogue and educational materials in Korean. The Consolidated Criteria for Reporting Qualitative Research (COREQ) were used [23].

Participants

This study used purposive sampling, and the amount of information was based on the principle of saturation. Purposive sampling involves extracting the people, places, and events that can provide the most information about a research problem [24]. Purposive sampling is a characteristic of qualitative design and is frequently used in nursing research [20]. This involved identifying and selecting individuals who had knowledge of the phenomenon of interest and were willing to participate. This is particularly important when conducting qualitative research on target participants, who can provide a rich description of the phenomenon in question [20]. The selection criteria for the study participants were as follows: (1) fourth-year nursing students enrolled in 2023; (2) students who participated in the VR simulation class; and (3) students who voluntarily participated in this study. The exclusion criteria were as follows: (1) students who missed more than one class, and (2) students who did not agree to participate in the study. When analyzing the 32nd reflection journal, no new themes emerged; therefore, the information was saturated, after which it was analyzed for accuracy. On the first day of the VR simulation class, students were provided with a guide to conduct the research, and the research purpose and methods were explained to them. Those who agreed were asked to sign a written consent form. In total, 64 nursing students who were enrolled in a VR simulation course were invited to participate in the study, and 48 agreed ($N = 48$).

Ethics approval

This study was approved by the Bioethics Committee of Dongyang University (IRB no.1041495-202312-HT-05-01 Approval date:15.12.2023). The researchers explained the aims and methods of this research to the participants in writing, explaining that confidentiality was protected and participation in the research was completely voluntary. Informed consent was obtained from all the participants. All methods were performed in accordance with relevant guidelines and regulations. In addition, participants were informed that they could leave the study at any time without providing any reason. All the procedures were performed in accordance with the Declaration of Helsinki. Confidentiality and anonymity were guaranteed and the recordings were not used for any purpose other than research.

Data collection

The class ran for 13 weeks, and the reflection journal was written freely on A4 paper in the classroom after the final class. There was no time limit for writing. The data collection period for this study spanned December 16–25, 2023. The VR class for patients with pneumonia included 60 participants. After the study was explained, 48 students agreed to participate. All participants provided written informed. The reflective journal was written based on Kim's Critical Reflective Inquiry model [25], which is a three-part structure that serves as a framework for reflective journaling interventions; it includes descriptive, reflective, and critical Sect. [25]. The reflection journal used a semi-structured question format tailored to the research purpose, allowing nursing students to write freely based on previous research. In the descriptive section, participants wrote about meaningful events that occurred during orientation. In the reflective section, participants wrote about their feelings about the situation and whether things went well. Finally, in the critique section, participants wrote about what they learned from the situation and how they would act as nurses in the future. A semi-structured question list was used to encourage spontaneous writing of the research topics, and open-ended questions designed to clarify the students' experiences were also included [26]. The form was reviewed by experts in VR simulation and qualitative research to ensure the appropriateness of the questions. The questionnaire was completed after receiving feedback. A pilot reflective journal survey was conducted with three students who were not included in the sample to ensure that the questions were sufficiently clear and easy to understand. Data from the pilot interviews were excluded from the analysis. The questions were, "What was your memorable experiences in the VR simulation class?" "What did you like or find disappointing in the VR simulation class?" "What did you learn from the VR simulation class?" Participants also provided information about their general characteristics, such as grade and gender. The participants were provided with a comfortable and quiet environment to reduce environmental distractions while writing their journals.

VR simulation-based pneumonia patient education program and practice environment

This study utilized the pneumonia patient VR program for adults developed by NewBase, a medical edu-tech company [27]. The program was designed to facilitate the exploration of hospital environments, observation of patient conditions, and immersion in clinical scenarios. The practice environment for implementing the VR education program utilized specialized equipment that integrated hand-motion tracking technology, replacing traditional controllers, and an Oculus Quest 2 HMD to enhance the practice of nursing skills. The setup is based on lightweight laptop hardware, enabling portability, efficiency, and operation anywhere without restrictions.

VR simulation performance process

In this program, the participants learned how to identify patients, communicate effectively with them, detect changes in a patient's condition, communicate with other medical staff, and administer the necessary treatments through a simulation game. The participants also received feedback on their individual learning progress, which could be used for debriefing after the simulation. The main procedures covered in this program included physical assessment, checking patient-monitoring devices, measuring vital signs, oxygen administration, tracheal suction, intravenous injection, intravenous administration, and operating infusion pumps. Scenario-based 3D virtual experience learning was conducted using an Oculus VR headset for VR (HMD) connected to a laptop. A VR program for patients with pneumonia was conducted using an Oculus Quest headset, a two-handed controller, and a Samsung desktop computer. The participants formed groups of four to five people, arranged their desks into groups, and studied together. The VR skill practice was delivered to the PC through mirroring, and students observed the VR skill practice performance process together. The specific execution processes are listed in Table 1; Fig. 1.

Data analysis

The content analysis of the written text consisted of three main phases: preparation, organization, and reporting. In Phase 1, the questionnaires were read and reread to understand the data. In Phase 2, the coded data were open-coded and grouped based on shared concepts and final abstractions. In the reporting phase, the results were described according to the content of the themes, and the research questions were addressed [22, 28].

For qualitative content analysis [21], the contents of the reflection journal were first transcribed using Microsoft Excel, and the reflection journal notes were edited. The researchers read the transcripts to familiarize themselves with the data. They then extracted the most relevant words and phrases to describe the nursing students' experiences in the VR simulation. The researchers read all transcripts and extracted sentences that conveyed the most meaningful information related to the nursing students' experiences. They then prepared a coding sheet and grouped, categorized, and abstracted the data. Data categorization was performed several times by researchers who worked closely together until four main categories were identified. As a confirmatory test, the four categories were shown to the students who agreed that the results accurately represented their experiences [21]. Data were analyzed using inductive content analysis. The data were divided into meaningful units and organized using open codes [21]. The analysis included grouping open codes ($n = 370$) into subcategories ($n = 138$), assigning descriptive names based on content ($n = 10$), and grouping them into major categories ($n = 4$) [29].

Rigor

This study ensured rigor using the criteria of confirmability, reliability, trustworthiness and transferability [30]. We strengthened confirmability by bracketing and maintaining a clear and easy-to-follow audit trial for all research activities and analysis notes. To enhance trustworthiness, we conducted peer debriefings and reviewed data, codes, subthemes, and themes. The extracted codes and

Table 1 VR simulation performance process

Day	Time taken	Topic	Content
Day1	2 h	Pre-learning about nursing patients with pneumonia	Check pneumonia patient information Learning necessary nursing skills (oxygen, intravenous injection, suction, etc.)
	2 h	Pneumonia patient VR basic mode practice	Experience basic pneumonia patient care in VR basic mode
Day2	2 h	In-depth lectures on nursing patients with pneumonia	Learn about the nursing care needed for pneumonia patients and the reasons for its application
	2 h	Pneumonia patient VR application mode practice	Experience more diverse nursing techniques through VR pneumonia patient application mode
Day3	2 h	Check scores after testing in pneumonia patient VR application mode	Test within the time limit using the application mode you practiced
	2 h	Debrief while checking each person's recorded VR technique video	Participants watch their own skill videos to assess areas of improvement and identify strenghts

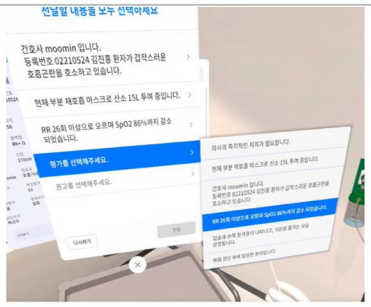
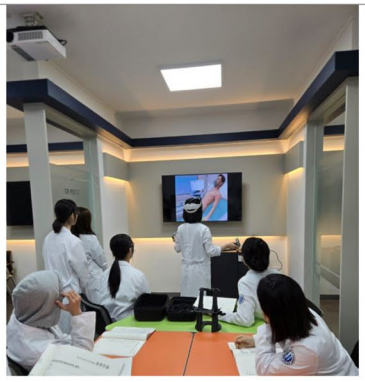
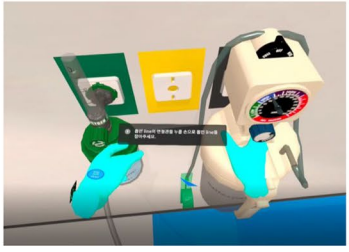
Component	Description	Activity scene
Patient condition display	Symptoms such as shortness of breath, use of an oxygen mask, and vital signs monitor	 (The patient's EMR in the VR simulation)
Learner perspective	First-person view with interactive VR controllers	 (Participant using a VR simulation for pneumonia care)
Nursing interventions	Lung auscultation, oxygen administration, and vital sign assessment and airway suctioning	  

Fig. 1 Components displayed in the VR simulation for pneumonia care

Table 2 General characteristics

	Men ($n=12$)	Women ($n=48$)
Gender (%)	20	80
Average Age	24 ± 1.45	
Grade	4	
Major	Nursing	

results were retrieved and shared with the participants to verify the consistency of the codes with their experience. Trustworthiness was achieved by having more than one researcher involved in the data analysis. Selecting participants with different demographic characteristics improved the generalizability of the findings. To increase transferability, the study results were provided to three nursing students, and the extent to which the results matched their experiences was examined.

Result

In this study, we used reflection journals written by fourth-year nursing students who had experienced VR simulations of patients with pneumonia at a nursing school in Korea (Table 2). Out of the 48 people, 38 were women and 10 were men, with an average age of 23 ± 1.45 years.

Four main categories were identified that described the VR simulation nursing experience of patients with pneumonia (Table 3). This study focused on four main areas: (1) enhancing various nursing skills for patients with pneumonia, (2) improving nursing communication skills, (3) creating a learning environment using VR technology, and (4) increasing awareness of nursing capabilities through VR.

Enhancing various nursing skills for patients with pneumonia

Enhancing various nursing skills for patients with pneumonia can be classified into two categories: (1) learning nursing skills, and (2) providing accurate nursing interventions based on the patient's condition. Through the VR simulation, participants had the opportunity to practice nursing skills that they had only observed in the field, but had never attempted during clinical or on-campus training. They were able to receive Total Parenteral Nutrition (TPN) and high-flow care for the first time. Additionally, they were able to independently review previously learned nursing techniques.

> *I can confirm that it can be revised once again to attempt to classify the nasopharyngeal airway, the intervention that is effective when prescribing TPN, and the high-flow specialized nasogastric tube (P29).*

> *Assessing the patient seems to be the most important thing. And since I was able to do the procedures that needed to be done in order, one by one, I was able to memorize the procedure order well (P30).*

The participants also learned that the nursing skills provided to patients were part of a continuous process within the overall care flow. This confirmed the patient's specific symptoms and the corresponding doctor's orders. Therefore, they were able to confirm changes in patients before and after their own nursing performance, and learn the procedures for providing nursing care after receiving a doctor's order.

> *I learned that accurate patient identification, following doctor's orders, and monitoring the patient's condition before and after treatment are crucial (P39).*

> *I learned that before reporting to the doctor, I need to make sure that I have thoroughly checked everything that I can before reporting. (P23)*

Enhancing nursing communication skills

The theme of enhancing nursing communication skills was included in two categories: (1) enhanced capability to evaluate patients and (2) learning to communicate medically.

Table 3 Content analysis of a virtual reality-based simulation experience for pneumonia patients

Subcategories	Main categories
Acquire nursing skills	Enhancing Various Nursing Skills for Pneumonia Patients
Provide accurate nursing interventions based on the patient's condition	
Enhanced capability to evaluate patients	Enhancing Nursing Communication Skills
Learn how to communicate medically	
Create a realistic learning environment	Creating a learning environment using VR technology
Recognize the necessity of technical support to enhance learning efficiency	
Disappointment regarding the discrepancy from actual nursing skills	
Gaining Confidence as a Prospective Nurse	Enhancing awareness of nursing capabilities through VR
Learn from mistakes	
Develop a sense of professional responsibility	

Because the participants had little experience in assessing patients through direct conversation and providing necessary nursing interventions in clinical practice conducted in hospitals, it was meaningful to ask patients questions and provide interventions for discovered health problems, even though this was done virtually.

> *Originally, nurses were supposed to ask about the patient's symptoms and provide appropriate nursing intervention according to the symptoms. Still, I felt like I did not properly listen to the patient telling me about his condition, so I thought it needed to be modified (P34).*

> *I was able to directly feel the discomfort felt by the patient, so I learned what to be careful about (P15).*

As they had no experience notifying doctors about patients' health problems, they were able to learn the order and method of virtual notification and practice it as if they were actually doing so. Additionally, through the handover process with medical staff, they could practice reporting on the nursing tasks they had performed.

> *By notifying the doctor directly, I felt that my confidence had increased, as I practiced once again how to communicate accurately about patient care. Reflecting on the simulation experience, I realized that I could conduct a handover with less nervousness (P17).*

> *I think it is important for doctors and nurses to communicate using SBAR (Situation, Background, Assessment, Recommendation) (P47).*

Creating a learning environment using virtual reality technology

Creating a learning environment using VR technology includes three categories: (1) creating a realistic atmosphere, (2) the necessity of technical support to enhance learning efficiency, and (3) disappointment that it does not match actual nursing skills.

In the VR scenario, a virtual patient experienced symptoms and exhibited physical reactions similar to those of an actual patient with pneumonia. He coughed constantly, had difficulty breathing, and his face became pale. In this realistic VR environment, the participants were able to experience a sense of vitality.

> *The patient coughing continuously made the situation vivid. When the patient complained of difficulty breathing, their skin became pale, making it easier to empathize and understand the situation (P52).*

> *It was a machine that could not be touched during clinical practice, but it was helpful to be able to touch it even through VR (P20).*

The participants performed the nursing tasks according to the instructions provided in the VR environment. However, they sought an explanation of the theoretical basis for why these tasks should be performed. They sought a clear rationale for their nursing practice.

> *I believe it would be advantageous to include a clear explanation of the theoretical foundation supporting the need for the nursing intervention I offer to patients with VR pneumonia, possibly in a pop-up window (P44).*

> *I would like to see a description of the rationale for why this patient maintains fasting and the core procedure steps (P2).*

In the VR program for patients with pneumonia, only the prescribed nursing skills were required; therefore, the participants were unable to provide any additional nursing care. They thought that it would be nice to add functions that participants could actively engage in, such as changing positions or performing deep breathing exercises for patients with pneumonia.

> *I believe it would have enhanced the patient's comfort more if I had said something like, "Please take a deep breath" when the patient was having difficulty breathing, and his skin turned pale. In addition, it would have been nice to change the patient's position from semi-sitting to sitting (P27).*

> *I felt that VR was a little less realistic than reality and that some parts were not implemented (P13).*

> *I was disappointed that there was no information necessary for nursing diagnosis, such as the patient's condition, other than the scenario (P35).*

Enhancing awareness of nursing capabilities through virtual reality

Enhancing awareness of nursing capabilities through VR includes three categories: (1) gaining confidence as a prospective nurse, (2) learning from mistakes, and (3) feeling a sense of professional responsibility.

Participants experienced working as nurses, which boosted their confidence in their ability to care for patients with pneumonia in the future.

I am confident that this process will allow me to provide better care when I encounter patients with similar cases in future clinical trials (P39).

I really enjoyed learning about the settings used in medical devices, getting familiar with the procedures, and indirectly experiencing being a new nurse (P28)

This was an opportunity for the participants to recognize the mistakes they made during the VR simulation process and learn from them. They were able to quickly notice changes in the virtual patient and modify behaviors related to nursing care procedures.

I made many mistakes, but this was the time when I learned more. Once again, I learned clearly that it is necessary to quickly recognize changes in a patient's condition and provide appropriate nursing care (P2).

I liked that it gave me a chance to think about what I did wrong, like not being able to move on to the next step if I put the ECG in the wrong place or did not do it properly (P 24).

I learned that if I did not take immediate action, the patient would be at risk (P 41).

These scenarios gave participants the opportunity to envision themselves as future nurses and experience professional responsibilities. No actual harm occurred if a mistake was made in the VR simulation. However, this experience allowed them to contemplate their skills and the potential issues that could have arisen if they had been treating actual patients.

In VR settings, performing tasks under pressure is less stressful for patients. In a real situation, it would be frustrating to face the challenge of selecting the appropriate oxygen delivery method (nasal cannula, mask, high flow, etc.) and providing nursing care while interacting with patients. (P47).

I am worried that I will panic when the patient's condition suddenly worsens in actual clinical practice. I want to calmly apply what I have learned now (P21).

The results of an integrated analysis of the four main categories (enhancing various nursing skills for pneumonia patients; enhancing nursing communication skills; creating a learning environment using virtual reality technology; and enhancing awareness of nursing capabilities through virtual reality) are as follows. Through the pneumonia VR simulation class, we discovered that VR was a new alternative to improve nurses' abilities to care for patients with pneumonia in clinical practice settings. Students improved their performance because they were able to touch and operate high-risk equipment that directly affected patients, which they had previously only observed; they were given the opportunity to try again even if they made mistakes, so they were able to identify their mistakes. Additionally, VR simulations are expected to help students improve their performance by systematically learning nursing, communication, and reporting skills.

Discussion

This study employed a qualitative descriptive design that utilized reflective journals [20] that were then analyzed using qualitative content analysis [21]. This study explored the experiences of nursing students in a virtual reality (VR) simulation of a patient with pneumonia. The study participants were 48 students who took a VR simulation class in their final semester; all participants had completed on-campus clinical practice in earlier semesters. Data were collected through reflection journals written by students after their learning sessions and analyzed using content analysis.

The first identified category was "Enhancing various nursing skills for pneumonia patients." Nursing skills were enhanced using various techniques integrated into a VR simulation program. These techniques include intravenous injection, heparin locking, total parenteral nutrition (TPN) administration, the use of a high-flow oximeter, and lung auscultation. Previous studies have shown that pre- and post-knowledge surveys of gamified simulation interventions significantly improve test scores [31]. The post-simulation survey responses were consistent with previous data from gamified laboratory simulations [32]. Another study that utilized VR simulations in foreign language learning found that students reported a positive effect and enhanced their educational motivation [33]. In addition, these nursing techniques can be implemented within the overall flow of nursing interventions, beginning with the initial symptom complaints of hospitalized patients with pneumonia. This approach allowed nurses to envision the expected scenario when encountering an actual patient with pneumonia. Although their proficiency in nursing skills was enhanced, students responded positively to the safe environment and had the opportunity to practice these skills repeatedly. According to previous research, simulations can offer a range of unattainable experiences in hospital settings, and must ensure a safe environment [34]. Nursing students were accustomed to theory-oriented classes. However, they felt burdened by the unfamiliar practical nursing skills

and found the procedures complicated, leading to low confidence. VR ensures patient safety, even when practicing invasive nursing techniques such as intravenous injections. Consequently, nursing students can practice confidently without anxiety about harming patients, even if they make a mistake.

The second category identified was "Enhancing nursing communication skills."Effective communication skills are essential for nurses to interact with patients, doctors, and other healthcare professionals.

Previous studies have highlighted that nurses' ability to accurately assess patients is a crucial competency. During training with a virtual simulation scenario of osteomyelitis, the communication skills of the experimental group significantly improved compared with those of the control group [35]. A usability study of a VR-based community mental health evaluation found that participants could easily access and learn communication-related information using a VR scenario guide. Additionally, the participants reported feeling immersed in patient communication and experiencing realistic and engaging interactions [36]. In a study on the development of surgical prototypes, communication among team members was recognized as the most essential aspect of treating patients. Nurses anticipated surgeons' needs, made decisions regarding those needs, and optimized patient outcomes [37]. Thus, effective communication is crucial. Although direct voice communication is not currently available in VR simulations, structured guidance can help nursing students develop an understanding of essential assessment questions and protocols. It is also an opportunity for them to realize the importance of the communication process in conveying the results of their own assessments to a doctor as a nurse. Incorporating a voice-recognition function into VR scenarios should facilitate voice-based conversations between patients and educators. It is expected that the learning effect will be further enhanced if voice recognition functions are installed in future VR simulation programs.

The third identified category was "Creating a learning environment using VR technology." Nursing students expressed regret about solely following the scenarios provided in the VR simulation program, and most nursing students' decisions regarding patients in the VR environment were reactive rather than proactive. Although the nursing students wanted to engage in more autonomous nursing practices, they adhered to the scenario's guidance and regretted not being able to perform nursing interventions beyond the scope of the scenario. However, creating a virtual hospital-like environment in the classroom and practicing as if they were real nurses was a meaningful experience. A conceptual analysis of the clinical learning environment in nursing education highlighted the importance of creating a learning environment that integrates clinical practice to imbue students' learning with meaning and foster expertise through the provision of both physical and psychological spaces [38]. Accordingly, nursing education should progress toward reinforcing high-fidelity simulations with comprehensive technology integration, with a VR environment deemed suitable for this purpose. In one study that developed a VR training program prototype for surgical procedures, the participants suggested including surgical steps, associated surgical anatomy and pathology, and unexpected events to help users improve their knowledge and skills. Moreover, other findings which emphasize the importance of including individual modules in VR educational tools to allow VR users to advance their learning as the technology evolves align with this study [21]. Additionally, the absence of tactile sensations in VR programs may be considered a limitation in enhancing technical skills compared with traditional model practices. This mirrors the findings of a previous study which indicated that, while improvements in academic achievement were observed in the knowledge aspect with the application of VR education, no significant improvement was observed in the skills aspect [39]. VR-based nursing skills training requires further technological advancement, particularly the integration of haptic devices that provide tactile feedback. In current learning settings, VR programs should be used in conjunction with traditional modeling practices, rather than relying on them alone.

The fourth identified category was "Enhancing awareness of nursing capabilities through VR." The present study found that offering practical learning opportunities to nursing students enhanced their sense of responsibility, making this type of education crucial for nurses' preparation. By providing nursing students with a learning environment in which they could interact with pneumonia patients through VR, they were able to reflect on their cognitive processes and acquire the knowledge and skills necessary to fulfill their duties effectively, thereby enhancing their mental preparedness as future nurses. Plotzky et al. [40] confirmed that a VR program has the potential to bridge the theory-practice gap for nursing students by providing hands-on skills training while incorporating and applying nursing theory. Additionally, this was consistent with the observation that students believed their nursing skills improved as they experienced each dimension of the scenario rubric [41]. These results indicate that the use of virtual simulation is beneficial for learning and helps students improve their knowledge and clinical judgment skills. Through this process, the nursing students were able to recognize their mistakes and acknowledge the need to identify and address their shortcomings. Furthermore, as they transition to becoming nurses, they can anticipate mistakes

and develop the ability to practice nursing in a more prepared manner, ultimately enhancing their confidence.

Conclusion

This study explored the significance of VR simulation educational experiences for fourth-year nursing students caring for pneumonia patients. The findings were analyzed into four main categories: Enhancing various nursing skills for pneumonia patients, Enhancing nursing communication skills, Creating a learning environment using VR technology, and Enhancing awareness of nursing capabilities through VR. Based on these findings, VR simulation experiences can serve as a vital foundation for future nursing education, helping students improve their ability to apply nursing practice in real clinical settings. Furthermore, the VR simulation program including patients with pneumonia provides valuable evidence for enhancing learning outcomes from the learner's perspective. In this study, VR simulation education improved nursing students' competencies. Hybrid learning designs could ensure that VR simulation-based learning outcomes correlate with actual nursing competencies. VR simulations can be an effective and cost-efficient teaching method for enhancing nursing students' competency in caring for patients with pneumonia.

Limitations

This study has several limitations. First, we conducted an experiment using a previously developed VR simulation program. Researchers were unable to overcome certain limitations when developing and implementing programs that meet students' needs. To complement this, we propose developing and applying of various VR content and conducting follow-up research that targets diverse subjects. Second, prior experience with VR education was not controlled. We propose that students who have experienced VR education should be classified, and a comparative analysis should be conducted in future research that compares students who have experience with VR and those who have not when they experience this VR-based simulation regarding patients with pneumonia for the first time.

Acknowledgements
We thank all nursing students who participated in our study.

Author contributions
S. An: Conceptualization, methodology, validation, formal analysis, investigation, resources, data curation, writing – original draft, writing – review and editing, and visualization. Y-J Um: Conceptualization, Methodology, Validation, Formal analysis, Investigation, Writing- Original, visualization, Project administration. Formal analysis, Investigation, Writing- review.

Funding
This study was supported by a grant from Dong Yang University in 2023.

Data availability
The datasets generated and/or analysed during the current study are not publicly available due to a reason that data is a part of unpublished dissertation and data is in Korean but are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
This study was approved by the Bioethics Committee of Dongyang University (IRB no.1041495-202312-HT-05-01 Approval date:15.12.2023). This study adhered to the principles of the Declaration of Helsinki (Ashcroft, 2008) to safeguard the privacy and confidentiality of research participants. Informed consent was obtained from all the participants.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

Received: 16 August 2024 / Accepted: 28 April 2025
Published online: 06 May 2025

References

1. Krapp A. Interest, motivation and learning: an educational-psychological perspective. Eur J Psychol Educ. 1999;14:23–40.
2. Filgona J, Sakiyo J, Gwany DM, Okoronka AU. Motivation in learning. Asian J Soc Sci Stud. 2020;10(4):16–37.
3. Yu TC, Webster CS, Weller JM. Simulation in the medical undergraduate curriculum to promote interprofessional collaboration for acute care: a systematic review. BMJ Simul Technol Enhanc Learn. 2016;2(3):90.
4. Fabris CP, Rathner JA, Fong AY, Sevigny CP. Virtual reality in higher education. Int J Innov Sci Math Educ. 2019;27(8).
5. Lin YJ, Wang HC. Using virtual reality to facilitate learners' creative self-efficacy and intrinsic motivation in an EFL classroom. Educ Inf Technol. 2021;26(4):4487–505.
6. Choi J, Thompson CE, Choi J, Waddill CB, Choi S. Effectiveness of immersive virtual reality in nursing education: systematic review. Nurse Edu. 2022;47(3):E57–61.
7. Health Insurance Review & Assessment Service. Current issues in healthcare utilization in Korea. HIRA Research. 2021;1(1):81–84. Available at: https://doi.org/10.52937/hira.21.1.1.81[Accessed 12 Apr. 2025].
8. Statistics Korea. Reason for death in 2020 [Internet]. Daejeon: Statistics Korea. http://kostat.go.kr/wnsearch/search.jsp. The levels of unmet care needs after discharge in patients with chronic pulmonary disease, colorectal cancer, and strokes. Journal of Korean Clinical Nursing subjects. https://www.wma.net/policies-post/wma-declaration-of-helsinki-ethicalprinciples-for-medical-research-involving-human-subjects. [Accessed 12 Apr. 2025].
9. Kneebone R. Simulation in surgical training: educational issues and practical implications. Med Educ. 2003;37(3):267–77. https://doi.org/10.1046/j.1365-2923.2003.01440.x.
10. Plotzky C, Lindwedel U, Sorber M, Loessl B, König P, Kunze C, et al. Virtual reality simulations in nurse education: a systematic mapping review. Nurse Educ Today. 2021;101:104868. https://doi.org/10.1016/j.nedt.2021.104868.
11. Wiecha J, Heyden R, Sternthal E, Merialdi M. Learning in a virtual world: experience with using second life for medical education. J Med Internet Res. 2010;12(1):e1337. https://doi.org/10.2196/jmir.1337.
12. Lungu AJ, Swinkels W, Claesen L, Tu P, Egger J, Chen X. A review on the applications of virtual reality, augmented reality and mixed reality in surgical simulation: an extension to different kinds of surgery. Expert Rev Med Devices. 2021;18(1):47–62. https://doi.org/10.1080/17434440.2021.1860750.
13. Yung R, Khoo-Lattimore C, Potter LE. Virtual reality and tourism marketing: conceptualizing a framework on presence, emotion, and intention. Curr Issues Tour. 2021;24(11):1505–25. https://doi.org/10.1080/13683500.2020.1820454.
14. Jallad ST, Işık B. The effectiveness of virtual reality simulation as learning strategy in the acquisition of medical skills in nursing education: a systematic

review. Ir J Med. 2021;191:1407–26. https://doi.org/10.1007/s11845-021-02695-z.
15. Chang YM, Lai CL. Exploring the experiences of nursing students in using immersive virtual reality to learn nursing skills. Nurse Educ Today. 2021;97:104670. https://doi.org/10.1016/j.nedt.2020.104670.
16. Nassar AK, Al-Manaseer F, Knowlton LM, Tuma F. Virtual reality (VR) as a simulation modality for technical skills acquisition. Ann Med Surg. 2021;71. https://doi.org/10.1016/j.amsu.2021.102945.
17. Brown KM, Swoboda SM, Gilbert GE, Horvath C, Sullivan N. Integrating virtual simulation into nursing education: A roadmap. Clin Simul Nurs. 2022;72:21–9. https://doi.org/10.1016/j.ecns.2021.08.002.
18. Li YY, Au ML, Tong LK, Ng WI, Wang SC. High-fidelity simulation in undergraduate nursing education: A meta-analysis. Nurse Educ Today. 2022;111:105291. https://doi.org/10.1016/j.nedt.2022.105291.
19. Flood LS. Use of virtual reality simulations to embody a patient: exploring the impact on nursing students' confidence, feelings, and perceptions. Nurse Educ. 2024;49(1):36–40. https://doi.org/10.1097/NNE.0000000000001442.
20. Polit DF, Beck CT. Generalization in quantitative and qualitative research: Myths and strategies. Int J Nurs Stud. 2010;47(11):1451–8. https://doi.org/10.1111/j.1365-2648.2007.04569.x.
21. Elo S, Kyngäs H. The qualitative content analysis process. J Adv Nurs. 2008;62(1):107–15. https://doi.org/10.1111/j.1365-2648.2007.04569.x.
22. Kim H, Sefcik JS, Bradway C. Characteristics of qualitative descriptive studies: A systematic review. Res Nurs Health. 2017;40(1):23–42.
23. Tong A, Sainsbury P, Craig J. Consolidated criteria for reporting qualitative research (COREQ): a 32-item checklist for interviews and focus groups. Int J Qual Health Care. 2007;19(6):349–57. https://doi.org/10.1093/intqhc/mzm042.
24. Sun YL, Luo LH. Study on education research sampling——Purpose sampling. J Yunnan Normal Univ (Phil Soc Sci Edition). 2002;34(3):127–9.
25. Schuler MS. Simulation debriefing using Kim's critical reflective inquiry model. Nurse Educ. 2020;45(5):272. https://doi.org/10.1097/NNE.0000000000000819.
26. Ridder HG. Qualitative data analysis. A methods sourcebook 3rd edition. City: Publisher; 2014.
27. NewBase. 2024. Nursebase. Available at: https://www.newbase.kr/#nursebase [Accessed 12 Apr. 2025].
28. Webster C. Effects of researcher presence and appeal on response quality in hand-delivered, self-administered surveys. J Bus Res. 1997;38(2):105–14.
29. Kyngäs H, Kääriäinen M, Elo S. The trustworthiness of content analysis. In: Kyngäs H, Mikkonen K, Kääriäinen M, editors. Application of content analysis in nursing science research. Cham: Springer; 2020. pp. 41–8. https://doi.org/10.1007/978-3-030-30199-6_5.
30. Guba EG. Criteria for assessing the trustworthiness of naturalistic inquiries. ECTJ. 1981;29(2):75–91.
31. Tsirulnikov D, Suart C, Abdullah R, Vulcu F, Mullarkey CE. Game on: immersive virtual laboratory simulation improves student learning outcomes & motivation. FEBS Open Bio. 2023;13(3):396–407.
32. Makransky G, Bonde MT, Wulff JSG, Wandall J, Hood M, Creed PA, et al. Simulation based virtual learning environment in medical genetics counseling: an example of bridging the gap between theory and practice in medical education. BMC Med Educ. 2016;16:98.
33. Shefieva E, Simonova O, Bessarabova O. Virtual simulators application in the foreign language studying as the factor of students motivating. In SHS Web of Conferences, Location: EDP Sciences. 2022;137:01024.
34. Blackmore A, Kasfiki EV, Purva M. Simulation-based education to improve communication skills: a systematic review and identification of current best practice. BMJ Simul Technol Enhanc Learn. 2018;4(4):159. https://doi.org/10.1136/bmjstel-2017-000220.
35. Foronda CL, Hudson KW, Budhathoki C. Use of virtual simulation to impact nursing students' cognitive and affective knowledge of evidence-based practice. Worldviews Evid Based Nurs. 2017;14(2):168–70. https://doi.org/10.1111/wvn.12207.
36. Verkuyl M, Romaniuk D, Atack L, Mastrilli P. Virtual gaming simulation for nursing education: an experiment. Clin Simul Nurs. 2017;13(5):238–44. https://doi.org/10.1016/j.ecns.2019.02.001.
37. Armour T, Nicholson P. Determination of skill and knowledge requirements of an instrument nurse working in major vascular surgery for the development of a virtual reality training tool. Clin Simul Nurs. 2023;79:40–8. https://doi.org/10.1016/j.ecns.2023.02.005.
38. Fogget N, Kubin L, Wilson CE, Trinka M. Using virtual simulation to develop clinical judgment in undergraduate nursing students. Clin Simul Nurs. 2020;48:55–8. https://doi.org/10.1016/j.ecns.2020.08.010.
39. Haerling KA. Cost-utility analysis of virtual and mannequin-based simulation. Simul Healthc. 2018;13(1):33–40. https://doi.org/10.1097/SIH.0000000000000280.
40. Plotzky C, Lindwedel U, Sorber M, Loessl B, König P, Kunze C, et al. Virtual reality simulations in nurse education: a systematic mapping review. Nurse Educ Today. 2021;101:104868.
41. Flott EA, Linden L. The clinical learning environment in nursing education: a concept analysis. J Adv Nurs. 2016;72(3):501–13. https://doi.org/10.1111/jan.12861.

Publisher's note