



# 모바일 기반 가상 간호 시뮬레이션 콘텐츠 개발 및 적용: 혼합방법연구

김현선<sup>1)</sup> · 강지영<sup>2)</sup>

1) 을지대학교 간호대학, 조교수 · 2) 제주대학교 간호대학 · 건강과간호연구소, 부교수

## Development and application of the mobile-based virtual nursing simulation training content: A mixed methods study

Kim, Hyun-Sun<sup>1)</sup> · Kang, Jiyoung<sup>2)</sup>

1) Assistant Professor, College of Nursing, Eulji University

2) Associate Professor, College of Nursing · Research Institute of Health and Nursing, Jeju National University

**Purpose:** Nursing clinical practice education is transforming with the advent of mobile education and the unique experiences it offers in caring for virtual patients. For this innovative approach, this study aims to evaluate the efficacy of mobile-based virtual women's breast cancer nursing simulation training content on nursing students' confidence, satisfaction, and learning flow. It also examines the nursing students' virtual patient care experiences. **Methods:** A mixed methods approach using a convergent design was employed to examine students' cancer care confidence and satisfaction, learning flow, and learning experiences. Quantitative data through online questionnaires and qualitative data through focus group interviews were collected, merged, and analyzed. **Results:** This study developed a virtual nursing training module aimed at caring for women with breast cancer, a novel approach to facilitate mobile-based simulation training for nursing students. Data were analyzed using descriptive analysis, a chi-squared test, Fisher's exact test, t-test for participant homogeneity (experimental: 20, control: 20), independent t-test, and paired t-test. Satisfaction ( $t=3.53$ ,  $p=.001$ ) and confidence ( $t=4.07$ ,  $p=.001$ ), as well as flow ( $t=3.78$ ,  $p=.001$ ), significantly improved in the experimental group compared to the control group. Two core themes and five sub-themes were derived from the experimental group's experiences acquired by caring for women with breast cancer virtually, including that the students "Virtually cared for breast cancer patients, learning as if real." **Conclusion:** The mobile-based virtual nursing simulation training content allowed nursing students to upgrade their comprehensive nursing care skills by experiencing a fun and practical environment made possible by a new learning method.

**Keywords:** Mobile applications, Nursing education, Oncology nursing, Simulation training, Virtual reality

## Introduction

Technology integration in the educational sector has revolutionized traditional learning methods in recent years,

providing innovative and interactive platforms that enhance student engagement and learning outcomes. However, the current landscape of nursing education, often characterized by limited clinical placements and the need to adapt to rapidly evolving

**주요어:** 모바일 애플리케이션, 간호교육, 종양간호, 시뮬레이션 훈련, 가상현실

**Address reprint requests to:** Kang, Jiyoung

College of Nursing · Research Institute of Health and Nursing, Jeju National University,

102, Jejudaehak-ro, Jeju-si, Jeju-do, 63243, Republic of Korea

Tel: +82-64-754-3757, Fax: +82-64-702-2686, E-mail: jiyoungkang@jejunu.ac.kr

**Received:** July 22, 2024 **Revised:** August 6, 2024 **Accepted:** August 9, 2024

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healthcare practices, necessitates innovative teaching methods to prepare competent and confident nursing professionals. Mobile-based learning, in particular, has garnered significant attention due to its flexibility, accessibility, convenience, and potential for simulation training that allows users to experience real-life scenarios by caring for virtual patients [1,2]. This shift has also begun to influence nursing education, offering learners new experiences and learning methods that improve their education quality [3-5].

In nursing education, simulation training using virtual patients has emerged as a promising approach to bridge the gap between theoretical knowledge and practical skills [6]. However, comprehensive literature on the overall impact of mobile-based virtual nursing simulations on various educational outcomes remains limited. Specifically, there is a lack of research on how these mobile simulations affect nursing students' learning engagement, confidence, and satisfaction. Additionally, there is a limited understanding of the experiential aspects of virtual patient care and how these experiences translate into actual clinical practice. To address these gaps, it is essential to investigate the multifaceted effects of mobile-based virtual nursing simulations. Understanding these impacts will provide valuable insights into the effectiveness of this educational tool and help identify the best ways to integrate it into nursing curricula. By exploring the various dimensions of how mobile-based simulations affect students, educators can design and incorporate these technologies more effectively, ultimately enhancing the overall quality of nursing education [7,8].

This study then evaluates the effectiveness of mobile-based virtual nursing simulation training content. The outcome variables selected for analysis were learning satisfaction, self-confidence, and flow, as these have been demonstrated to be significant predictors of academic success and positive learning experiences in nursing education [9,10]. It also explores its impact on nursing students' confidence, satisfaction, and learning engagement to conduct an in-depth analysis of the virtual patient care experience. By adopting a mixed methods approach, this research provides a holistic understanding of the educational benefits and challenges associated with mobile-based virtual nursing simulations. This comprehensive approach will contribute to a more nuanced understanding of the strengths and limitations of virtual simulations, driving future improvements and innovations.

Ultimately, this study can contribute significantly to advancing nursing education and identifying effective strategies for

integrating technology into the curriculum. Its findings will optimize mobile-based virtual simulations and provide practical insights for nursing educators. This direction will ensure that future nurses are well-prepared and equipped with the necessary skills and knowledge to meet the demands of modern healthcare environments. The results of this study will be crucial in helping nursing students learn more effectively and acquire the skills and knowledge needed in actual clinical settings, providing a sense of reassurance and confidence to patients.

This mixed-methods study addresses the gap in research on mobile-based virtual nursing simulations in breast cancer care. It comprehensively explains their impact on nursing students' confidence, satisfaction, learning flow, and experiences. The findings of this research will inform the development of effective simulation training programs for future nursing professionals, thereby contributing to the advancement of nursing education and practice.

## Methods

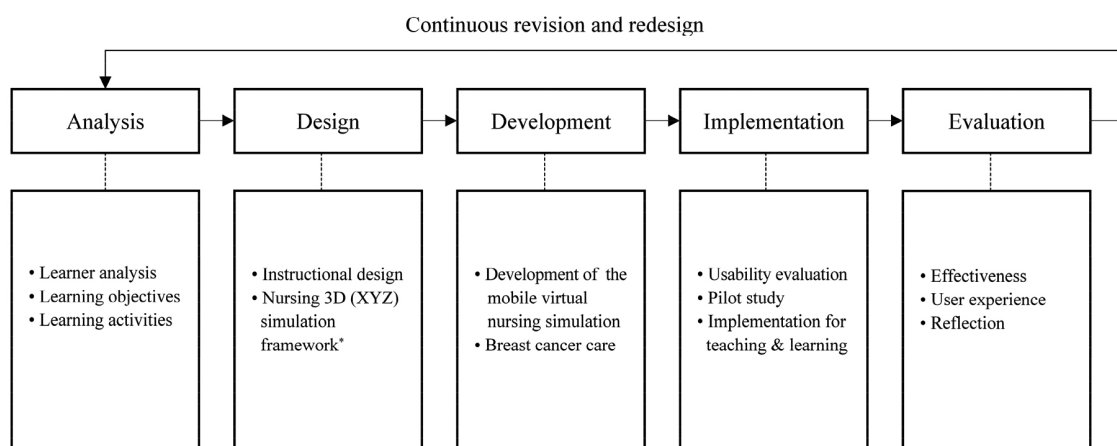
### Study design

This study employed a mixed-method approach using a convergent design to explore students' confidence, satisfaction, learning flow, and learning experiences in cancer care [11].

### Step 1: Development phase: Development of the mobile-based virtual nursing simulation training module

This phase involved a methodological approach to develop mobile-based simulation scenario modules. The content was carefully designed to provide an interactive and comprehensive learning experience for students in cancer care (Figure 1).

The virtual patient nursing simulation scenario used in this study focuses on the care of female breast cancer patients before and after surgery. Breast cancer is one of the most common cancers among Korean women [12], ranking first or second in incidence. It thus represents a significant area of potential nursing practice for nursing students once they become professional nurses. Therefore, it was selected as a representative case for cancer patient care. This scenario was developed based on the 3D simulation framework proposed by Suh [13], considering the content's difficulty and complexity. It was designed to incorporate



\* According to the nursing 3D simulation framework, each of the three axes--scope of practice, complexity, and student competency--is structured into three phases, guiding students towards achieving a high level of competency [13].

Figure 1. The development process of the mobile virtual nursing simulation for breast cancer care

the pre- and post-operative learning objectives the Korean Society of Nursing Science suggested in 2021 [14]. As a result, it was selected for the Simulation Contest of the Korean Society of Nursing Education in 2022, demonstrating its educational value.

The technical implementation was carried out in collaboration with a professional company. The scenario was divided into pre-operative and post-operative breast cancer care modules and implemented on an online learning platform. Students are given individual IDs and can participate in the learning process at their own pace and desired time and place. The study participants could utilize the content on mobile tablets or smartphones.

## Step 2: Experimental phase: Effects of the mobile-based virtual nursing simulation training module

The mobile content was evaluated using a mixed-methods approach with a convergent design, integrating quantitative (randomized controlled pretest-posttest) and qualitative (focus group interviews, FGIs) data to assess its effectiveness and understand the impact on students' learning experiences. In this study, after learning with the mobile-based nursing simulation content developed, the experimental group and the control group will have:

- Hypothesis 1: A difference in the change in simulation learning satisfaction scores.
- Hypothesis 2: A difference in the change in simulation learning

confidence scores.

- Hypothesis 3: A difference in the change in simulation learning flow scores.

### ● Quantitative research

- Setting and samples

This study was conducted from September 2021 to February 2022, targeting nursing students enrolled at a nursing college in Jeju City. The participants met the following selection criteria, understood the purpose of the study, and provided written informed consent for voluntary participation.

- 4th-year undergraduate nursing students
- Individuals who owned and could use a smartphone

To evaluate the effects of the study content, the research participants were selected from those with prior experience with simulation practice during their 3rd year. The sample size was calculated using the G\*Power 3.1.9.7 program, considering the effect size of .80~.96 from a previous study [15], a significance level of .05, and a power of 80%. This resulted in a sample size of 19 participants per group, and considering a dropout rate, 20 participants were recruited for each group. In this study, the participants were randomly allocated to the experimental and control groups using a random number table, and all participants completed the final survey without any dropouts.

The experimental group, having prior simulation experience, engaged in the mobile-based nursing simulation training intervention developed in this study for one week. With previous

simulation practice, the control group was informed of the option to utilize the content after the study's conclusion. However, no participants from the control group volunteered as the study coincided with their preparation for the Korean national nursing examination following the second semester.

- Measurements

#### **Learning satisfaction and confidence**

The Student Satisfaction and Self-Confidence in Learning instrument measured the participants' learning satisfaction and confidence after the mobile simulation practice [16]. The instrument consists of 13 items on a 5-point Likert scale, with two subscales: Satisfaction (5) and Self-Confidence (8). A higher score indicates higher satisfaction and self-confidence after the simulation practice. The National League for Nursing in the United States developed the instrument, and permission was granted for its use in this research. The measurement tool has been translated into Korean. The original Cronbach's alpha was .94 for the Satisfaction subscale and .87 for the Self-Confidence subscale. In this study, Cronbach's alpha was .89 for Satisfaction and .91 for Self-Confidence.

#### **Learning flow**

The Flow Short Scale developed by Engeser and Rheinberg [17] was used to measure the degree of engagement in the simulation practice. The scale was translated into Korean, and Yoo [18] verified its validity through a back-translation process. The scale was modified to a 5-point Likert scale to measure engagement in the simulation practice. The instrument consists of 10 items, and a higher score indicates a higher level of engagement in the learning activity. The original Cronbach's alpha was .92; in this study, it was .94.

#### **General characteristics**

We investigated the participants' age, sex, significant satisfaction, and the smartphone operating system they were using.

- Data collection and procedure

Data were collected after obtaining approval from the Institutional Review Board of Jeju National University (IRB No. JJNU-IRB-2021-025-001). A recruitment notice with a link was posted on an online bulletin board to recruit the study participants. Students who voluntarily wished to participate in the study were recruited. A research assistant responsible for participant

recruitment and random assignment randomly generated individual research IDs and used a random block allocation method based on a random number table to allocate participants to the experimental and control groups. The participants were blinded to their group allocation, and a double-blind procedure was applied, where the other researchers did not know the group assignments. Quantitative data were gathered by distributing online questionnaires to measure students' confidence, satisfaction, and learning flow. These questionnaires consisted of various items to evaluate how effectively students learned through mobile-based simulation modules.

- Statistical analysis

The statistical analysis of the quantitative data in this study was conducted using the IBM SPSS 24.0 program (IBM Corp.). The normality assumption was assessed using the Shapiro-Wilk test, and the data were found to be normally distributed. First, the participants' general characteristics were analyzed using frequency, percentage, mean, and standard deviation. Second, the homogeneity of the pretest between the experimental and control groups was tested using independent t-test, chi-square tests, and Fisher's exact test. Third, the differences in learning satisfaction, self-confidence, and learning flow scores between the experimental and control groups were analyzed using independent t-tests. In contrast, the differences between pre- and posttests were analyzed using paired t-tests. *p*-values less than .05 were considered statistically significant.

- Qualitative research

- Participants

The qualitative research participants were selected from the experimental group who consented to participate in the FGIs. Four FGIs were conducted to explore the learning experiences, each with 5 participants, for a total of 20 participants. The interviews for each group lasted between 30 and 50 minutes and were conducted via webinar.

- Focus group interviews: Learning experiences

A mobile simulation nursing practice module was developed, allowing students to use it freely for 1 week [15]. After that, FGIs were conducted to explore the students' learning experiences, such as their satisfaction, self-confidence, and engagement in learning. The key question was: What was your learning experience through the mobile simulation nursing practice module? The

detailed questions were: What are the pros and cons of the mobile simulation practice? Did you experience any learning effects? Why do you think that way? The interview questions were presented in a structured, sequential manner.

- Data collection and procedure

Qualitative data were collected through FGIs to understand students' learning experiences and perceptions of the mobile-based simulation practice. The semi-structured interviews encouraged students to express their thoughts and feelings freely. The interview content was recorded, transcribed, and coded by themes for analysis, allowing for the extraction of deep insights that could not be identified through quantitative data alone. By integrating quantitative and qualitative data, the study aimed to comprehensively evaluate the educational impact of the mobile simulation modules and identify areas requiring further improvement.

- Qualitative content analysis

The content of the FGIs was transcribed, and qualitative content analysis was used to identify the central themes and their relationships [19]. The participants' statements were read repeatedly and carefully to extract meaningful words, phrases, and sentences, which were then coded. Similar codes were grouped to classify the themes, and the final themes were derived. To ensure the rigor of the qualitative research, as suggested by Sandelowski [20], the credibility, fittingness, auditability, and confirmability of the study were verified to establish the validity of the findings. The credibility of the study was achieved through prolonged engagement with the participants and the triangulation of data sources, ensuring that the findings accurately represent the participants' perspectives. The fittingness of the findings to similar settings was demonstrated by comparing the research context and findings with existing literature. The auditability of the study was maintained by maintaining detailed records of the research process, which allowed for an external review of the methodological decisions and data analysis. Finally, confirmability was established by ensuring the findings were grounded in the data, with clear documentation of how interpretations were derived. Collectively, these strategies enhance the trustworthiness of the research and provide a solid foundation for the conclusions drawn.

## Ethical considerations

In conducting the research, informed consent was obtained in advance. Detailed information about the study's purpose, procedures, risks, and benefits was provided to all participants, and written consent was obtained before participation. This ensured that participants would voluntarily participate with complete understanding. To maintain confidentiality, participants' privacy was thoroughly protected. The collected data were anonymized to prevent individual identification, and care was taken to guarantee that no personal information was disclosed during the presentation of results.

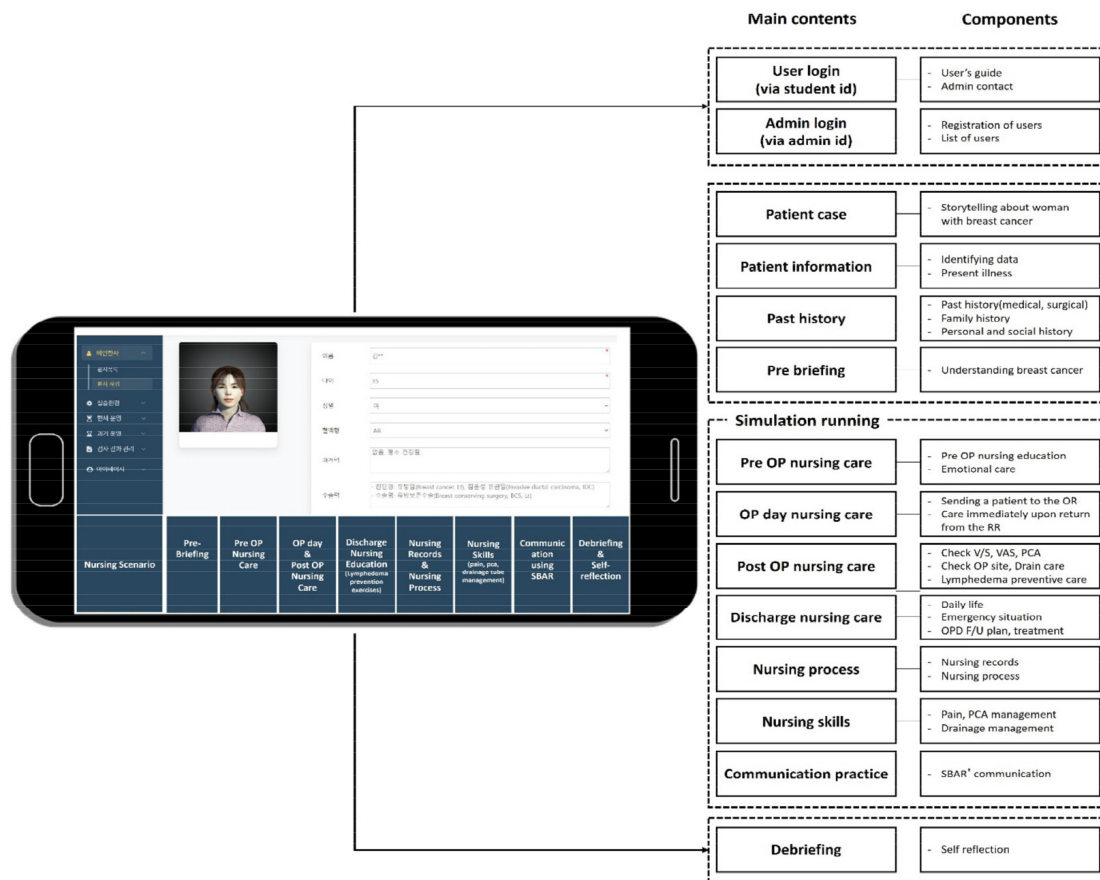
Data collection took place at one university. Recruitment was conducted after the end of the academic year, and grades were finalized to ensure that students from the researcher's university were not vulnerable. Participants were informed of their right to withdraw at any time. Data were securely stored and used solely for this study. Ethical guidelines were adhered to, ensuring participant anonymity and data confidentiality. Collected data will be destroyed upon study completion.

## Results

### Development phase: Development of a mobile simulation nursing practice module

The framework for three-dimensional nursing simulation education consists of three axes: the X-axis reflects the practice areas of the curriculum, the Y-axis demonstrates the complexity of the nursing situation, and the Z-axis reflects the staged competencies students should acquire through practice [13,14]. This study developed the module with the following axes: X<sub>1</sub>, adult health nursing course; Y<sub>2</sub>, individual-specific situation; and Z<sub>2</sub>, the student's competence to reenact nursing skills. Figure 2 shows the results of the mobile virtual nursing simulation training content developed for nursing students.

In the development process, a scenario for a breast cancer patient case was developed, and the content was designed to allow students to sequentially learn the pre-operative, post-operative, and discharge nursing processes. The pre-learning stage included content to help students understand the disease, facilitating patient assessment. The simulation scenario was divided into pre-operative and post-operative content, allowing students to apply the nursing process, write notes based on the process, and



F/U=follow-up; OP=operation; OPD=outpatient department; OR=operating room; PCA=patient-controlled analgesia; RR=recovery room; SBAR=situation, background, assessment, recommendation; V/S=vital signs; VAS=visual analogue scale

\* SBAR is a structured communication framework designed to facilitate concise and effective information exchange, particularly in critical or time-sensitive situations.

Figure 2. Essential elements of the mobile virtual nursing simulation for breast cancer site care

practice relevant nursing skills. Communication practice using the situation, background, assessment, recommendation method was also incorporated. In the final debriefing stage, students wrote individual reflection journals and received feedback on their nursing activities.

### Experimental phase: Effects of applying the mobile simulation nursing practice module

- Quantitative research
- General characteristics

The 20 experimental group participants used the mobile virtual nursing simulation training content for one week. The groups had no statistically significant difference in general characteristics

(Table 1).

- Homogeneity test of dependent variables

The mean pre-intervention satisfaction score in simulation-based learning was 4.32±0.31 points in the experimental group and 4.29±0.27 points in the control group. In contrast, the self-confidence score was 4.46±0.20 points in the experimental group and 4.30±0.35 points in the control group, with no statistically significant differences. The learning flow score was 4.30±0.24 in the experimental group and 4.09±0.42 in the control group. There were no statistically significant differences between the experimental and control groups in the three dependent variables. Therefore, the homogeneity test of the dependent



variables showed no statistically significant differences between the experimental and control groups (Table 2).

- Learning satisfaction, confidence, and flow

Table 3 compares the two groups' learning satisfaction, confidence, and flow. The level of satisfaction in the experimental group increased from 4.32 to 4.80 points, while the control group stayed at 4.27. There was a significant difference between the two groups ( $t=3.53$ ,  $p=.001$ ). The confidence level in the experimental group increased from 4.46 to 4.86 points, while the control group decreased from 4.30 to 4.23. There was a significant difference between the two groups ( $t=4.07$ ,  $p=.001$ ). The level of learning flow in the experimental group increased from 4.30 to 4.68 points,

while that in the control group decreased from 4.09 to 3.92. There was a significant difference between the two groups ( $t=3.78$ ,  $p=.001$ ). Hypotheses 1, 2, and 3 of the present study were all supported.

The effect size was calculated using the mean and standard deviation of the posttest learning satisfaction, learning confidence, and learning flow of the experimental and control groups [21,22]. The results indicated a large effect size for learning satisfaction ( $d=1.73$ ), learning confidence ( $d=2.23$ ), and learning flow ( $d=2.03$ ). The results demonstrated a large effect size greater than 0.8 according to the criteria established by Cohen [23], and learning satisfaction exhibited a vast effect size greater than 1.2 according to Sawilowsky's criteria [24]. Furthermore, learning

Table 1. Homogeneity Tests between the Two Groups at Baseline (N=40)

Characteristics	Categories	Exp. (n=20)	Con. (n=20)	$\chi^2/t$ ( $p$ )
		Mean $\pm$ SD or n (%)		
Age (years)		21.50 $\pm$ 1.53	21.45 $\pm$ 1.70	0.09 (.923)
Sex	Male	1 (5.0)	1 (5.0)	1.00* (.999)
	Female	19 (95.0)	19 (95.0)	
Satisfaction on nursing major		6.70 $\pm$ 1.26	6.85 $\pm$ 1.92	-0.29 (.772)
Smartphone OS	Android	5 (25.0)	8 (40.0)	0.50* (.311)
	iOS	15 (75.0)	12 (60.0)	

Con.=control group; Exp.=experimental group; OS=operation system; SD=standard deviation

\* Fisher's exact test

Table 2. Homogeneity Tests of the Outcome Variables at Baseline (N=40)

Outcome variables	Exp. (n=20)	Con. (n=20)	t ( $p$ )
	Mean $\pm$ SD		
Learning satisfaction	4.32 $\pm$ 0.31	4.29 $\pm$ 0.27	0.32 (.751)
Learning confidence	4.46 $\pm$ 0.20	4.30 $\pm$ 0.35	1.71 (.094)
Learning flow	4.30 $\pm$ 0.24	4.09 $\pm$ 0.42	1.91 (.063)

Con.=control group; Exp.=experimental group; SD=standard deviation

Table 3. The Effects of Mobile Virtual Nursing Simulation on Learning Satisfaction, Confidence, and Flow (N=40)

Variables	Group	Pretest	Posttest	Difference	t ( $p$ )
		Mean $\pm$ SD			
Learning satisfaction	Exp. (n=20)	4.32 $\pm$ 0.31	4.80 $\pm$ 0.31	0.48 $\pm$ 0.28	3.53 (.001)
	Con. (n=20)	4.29 $\pm$ 0.27	4.27 $\pm$ 0.42		
Learning confidence	Exp. (n=20)	4.46 $\pm$ 0.20	4.86 $\pm$ 0.15	0.40 $\pm$ 0.22	4.07 (.001)
	Con. (n=20)	4.30 $\pm$ 0.35	4.23 $\pm$ 0.37		
Learning flow	Exp. (n=20)	4.30 $\pm$ 0.24	4.68 $\pm$ 0.32	0.38 $\pm$ 0.21	3.78 (.001)
	Con. (n=20)	4.09 $\pm$ 0.42	3.92 $\pm$ 0.42		

Con.=control group; Exp.=experimental group; SD=standard deviation

confidence and engagement demonstrated a substantial effect size greater than 2.0.

● **Qualitative findings: Learning experiences**

The qualitative findings from this mixed methods study reveal the profound impact of a mobile-based virtual nursing simulation focused on the care of patients with breast cancer. Two overarching themes emerged from the student interviews, highlighting the educational value and authentic nature of the simulation-based learning experience.

**Theme 1. Learning by simulating patient care in vivid detail**

The virtual simulation enabled nursing students to engage deeply with the complexities of breast cancer care, enhancing their understanding and clinical competencies.

**1.1 Understanding the complex situation of pre- and post-operative processes for patients with breast cancer**

Students described how the simulation allowed them to comprehend the multifaceted patient journey, from diagnosis through surgical treatment and recovery.

*“The simulation helped me understand the full journey that breast cancer patients go through, from their initial diagnosis to the different treatment options and the recovery process. It gave me a much more comprehensive view of their experience.” (G4-4)*

*“I was able to virtually walk through the various stages of care, from the pre-operative preparations to the post-op complications that can arise. This allowed me to anticipate the patients’ needs and concerns at each step.” (G1-5)*

**1.2 Learning about various aspects of nursing cancer care**

The simulation allowed students to apply their knowledge and skills across various nursing interventions specific to oncology patients. This included managing symptoms, coordinating care, and educating patients—all within a safe, controlled environment.

*“The simulation exposed me to a wide range of nursing interventions specific to oncology patients, such as pain management, wound care, and patient education. I felt like I was getting hands-on practice in these critical skills.” (G3-4)*

*“Being able to virtually interact with the breast cancer patient, provide treatments, and monitor their responses was invaluable. It helped me integrate my knowledge into real-time clinical decision-making.” (G2-5)*

**1.3 A complementary learning tool for clinical practice**

Participants viewed the virtual simulation as a valuable supplement to their traditional clinical experiences. The simulation enabled them to practice critical nursing skills and refine their clinical judgment, better preparing them for real-world patient encounters.

*“The virtual simulation was a great supplement to my clinical rotations. It allowed me to practice nursing care safely before applying those skills with real patients.” (G1-4)*

**Theme 2. Feeling like a real-world experience**

In addition to enhancing their clinical competencies, the mobile-based virtual simulation fostered a sense of authenticity and investment in the patient’s care, as evidenced by the following subthemes:

**2.1 Feeling responsible as if I were a nurse in the virtual world**

Students described a profound sense of accountability and ownership over the virtual patient’s care, akin to caring for a real individual. This immersive experience cultivated heightened engagement and commitment to the patient’s well-being.

*“I felt genuine responsibility for the virtual patient’s well-being. It was as if I was their nurse fully invested in providing the best possible care.” (G1-3)*

**2.2 A feeling of self-confidence emerged in caring for patients with breast cancer**

Participating in the virtual simulation boosted students’ confidence in their ability to provide practical, compassionate nursing care for patients diagnosed with breast cancer.

*“After going through the virtual simulation, I feel much more confident in my ability to care for breast cancer patients. I now better understand the nursing process and how to meet their needs effectively.” (G2-5)*

## Discussion

The primary aim of this study was to develop a mobile-based virtual nursing simulation module focused on the care of patients with breast cancer and to evaluate its effects on nursing students’ learning satisfaction, self-confidence, and learning flow. This was also confirmed through the qualitative analysis of students’ learning experiences. The findings demonstrate the successful development of the simulation module, which was structured



around three fundamental axes: the practice areas of the nursing curriculum, the complexity of the nursing situation, and the staged competencies for students to acquire through practice.

The significance of this study is threefold: (1) it developed a comprehensive learning experience for students to ascertain the continuum of nursing care from the patient's perspective using a virtual medical record; (2) it assigned individual IDs to students, allowing their nursing activity progress to be tracked and enabling repeated learning; and (3) it provided a mobile-based clinical practice content that is flexible in terms of time and location. The evaluation of the module's effects revealed significant improvements in the experimental group's learning satisfaction, self-confidence, and learning flow compared to the control group. These quantitative results underscore the educational value of the mobile-based virtual simulation in enhancing nursing students' engagement and competence in oncology nursing.

Applying the developed mobile-based virtual nursing simulation content significantly improved nursing students' satisfaction, confidence, and immersion in learning breast cancer nursing. This study used an RCT design, and the post-evaluation included a FGI, representing a mixed-method approach. The intervention period was one week, during which students could comprehensively learn the temporal flow of the patient's hospitalization, pre-surgery, surgery, post-surgery, and discharge situations.

The qualitative findings further elucidated the profound impact of the simulation-based learning experience. Students described how the virtual simulation enabled them to deeply engage with the complexities of breast cancer care, developing a more nuanced understanding of the patient journey and the various nursing interventions required. Notably, the simulation fostered a sense of authenticity and responsibility, as if they were caring for an actual patient. This heightened sense of investment and self-confidence is a crucial outcome, as it will empower students to navigate the challenges of oncology nursing with greater competence and composure. These findings align with previous research highlighting the benefits of simulation-based learning in nursing education [9,10], particularly in enhancing clinical reasoning, technical skills, and professional identity development [25-27]. The mobile-based approach in the current study further extends the utility of simulation, providing students with the flexibility to engage in immersive learning experiences anytime, anywhere [15,28]. The analysis of the learning experiences revealed that students felt a sense of responsibility as nurses while vividly and meticulously learning the virtual patient case, which increased

confidence in caring for breast cancer patients. The ability to comprehensively understand the patient and practice the continuity of care from various perspectives was also a valuable learning experience. Given the demonstrated effectiveness of the mobile nursing simulation content developed in this study, it is expected to be used as a supplementary learning tool in the clinical practice curriculum in the future [29,30].

Overall, the qualitative findings underscore the transformative potential of mobile-based virtual simulations in nursing education. By creating an immersive, authentic learning environment, this innovative approach can significantly enhance students' clinical reasoning, technical skills, and professional identity as future nurses caring for individuals with breast cancer. Students valued the accessibility of the mobile-based virtual nursing simulations but preferred a collaborative learning environment with instructors and peers, ideally incorporating multiple simultaneous connections [15,28]. From a nursing education perspective, the developed mobile simulation module complements traditional clinical experiences, providing students with a safe environment to practice critical skills and refine clinical judgment, ultimately enhancing their preparation for oncology nursing practice.

The integration of quantitative and qualitative data in this study presents a compelling illustration of the beneficial impact of mobile virtual nursing simulation on nursing education [29]. The notable enhancements in learning satisfaction, self-assurance, and engagement observed in the experimental group, as corroborated by the quantitative analysis, are further elucidated by the qualitative findings. The students' narratives indicate a heightened appreciation for the immersive and authentic nature of the simulation [27], which has fostered a sense of responsibility and bolstered their confidence in providing breast cancer care. This convergence of evidence highlights the value of mobile virtual simulation in not only enhancing cognitive and affective learning outcomes but also in fostering the professional identity of future nurses. By bridging the gap between theoretical knowledge and clinical practice, this innovative approach has the potential to transform nursing education and prepare students for the complexities of oncology care.

This study has limitations due to its single-university setting and focus on mobile-based virtual simulation. Future research should include a more diverse sample of students and explore alternative delivery methods to enhance generalizability and accommodate varying technological preferences. Additionally, examining the impact of technology familiarity on learning

outcomes would be beneficial.

## Conclusion

In conclusion, this study successfully developed and evaluated a mobile-based virtual nursing simulation module focused on the care of patients with breast cancer. The findings demonstrate the effectiveness of the module in enhancing nursing students' learning satisfaction, self-confidence, and learning flow, as well as its potential to foster a profound sense of authenticity and responsibility in caring for oncology patients.

Based on the study's findings, the following recommendations are proposed: Integrate mobile-based virtual simulations into nursing curricula to provide students with diverse, accessible, and engaging learning opportunities. Expand the development and evaluation of mobile simulation modules across various nursing specialties to support nursing students' holistic preparation further. Investigate the long-term impact of mobile-based virtual simulations on nursing students' clinical competencies and professional development as they transition into clinical practice.

## Author contributions

**HS Kim:** Conceptualization, Methodology, Software, Data curation, Writing - original draft, Visualization. **J Kang:** Investigation, Supervision, Validation, Writing - review & editing, Project administration, Funding acquisition.

## Conflict of interest

No potential conflict of interest relevant to this article was reported.

## Funding

This work was supported by the research grant of Jeju National University in 2021.

## Acknowledgements

We would like to express our gratitude to the software development team for their dedication to the development and implementation of the virtual content. Furthermore, we would like to thank the students who used the content with great diligence

and provided valuable feedback.

## Supplementary materials

None

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