Development of a virtual reality program in South Korea for the measurement of vital signs in children: a methodological study

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Purpose: We developed a virtual reality (VR) program for use in pediatric nursing practicums to help nursing students learn to measure vital signs in children. **Methods:** The analysis, design, development, implementation, and evaluation model was employed between July 2021 and December 2021 at a university in South Korea. In the analysis phase, in-depth interviews were conducted with four nursing students, two nursing school graduates, and four experts. The topic and contents of the VR program were settled in the design phase. The VR program was developed and subsequently used and evaluated by 20 nursing students and four experts. **Results:** The contents of the VR program for pediatric nursing practicums included the measurement of vital signs in a newborn baby and a young child, as well as an evaluation system. The mean score for the nursing students' satisfaction with practice was 4.02 out of 5 points. The mean scores for overall satisfaction with the VR program were 4.15 and 4.79 out of 5 points for nursing students and experts, respectively. **Conclusion:** The VR program developed in this study allows nursing students to practice measuring vital signs in children, thus improving the students' clinical performance in pediatric nursing.

Key words: Virtual reality; Vital signs; Pediatric nursing; Students, nursing

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INTRODUCTION

Since nursing education emphasizes practical skills along with nursing knowledge, nursing practicums are very important. In many countries, including South Korea, practical training is required to obtain a nursing license [1]. The ability to make clinical decisions, communication skills, and the performance of nursing skills acquired during practical education play important roles in nursing competency after graduation [2]. Nursing students need hands-on experience and opportunities to practice various patient-care skills in their clinical practice education, but concerns about the safety of patients and students can make direct contact with patients difficult [3]. Furthermore, a recent decrease in the population of children in South Korea has led medical institutions to reduce the number of pediatric wards, making it difficult for nursing schools to secure child nursing practice centers. Not only are nursing students restricted from practicing directly on vulnerable children for safety reasons, but opportunities for students to closely observe the performance of experienced nurses are also limited [4].

As a result, there is an increasing demand for environments that provide vicarious clinical experiences. Simulation education using high-fidelity simulators is one option, but it is limited by cost and the need for space [5,6]. Recently, nurse educators have accessed advanced technologies, and various web-based methods of nursing education are being developed [7]. Virtual reality (VR) has been shown to increase students' engagement; therefore, researchers have explored the development and utilization of educational content using VR [8,9]. The term "VR" is used to describe a specific virtual environment or situation or to name the technology itself. Using artificial intelligence technology, an environment or situation is created that is realistic, but not real [10]. An educational method that uses VR allows students to make decisions and practice skills in a VR environment that is based on case sce-

narios [11].

Since nursing education using VR is performed on a virtual patient in a VR space, rather than on an actual patient, it is possible for students to safely repeat training skills without the risk of threatening patient safety. Through repetitive training in a VR environment, students can learn important nursing skills. When they become nurses, they can safely and skillfully care for patients [12].

As nursing education using VR has emerged as an alternative to traditional practice education [5], surveys have been conducted to assess the demand for VR education [13], various educational scenarios using VR have been developed, usability verification has been performed [14], and studies to analyze student experiences have been conducted [15,16]. In addition, due to technological development, the devices used for VR construction have become more common and less expensive, allowing for more studies to assess the effectiveness of knowledge, satisfaction, confidence, and learning flow of VR when applied to nursing education [17-19].

Although VR has been utilized to overcome and supplement the limitations of clinical practice education in child nursing, research on this method has been limited. A study of high-risk neonatal infection control [20] is one of the few that have been conducted. Therefore, in this study, we sought to develop a VR program for pediatric nursing practicums by first identifying the level of demand for VR practice education in child nursing intended to improve the child nursing practical skills of nursing students.

METHODS

Ethics statement: This study was approved by the Institutional Review Board of Seoul Women's College of Nursing (No. SWCN-202106-HR-004-02). Informed consent was obtained from all participants.

1. Research Design

This was a methodological study to identify the need for child nursing VR practice education and to develop a VR program for nursing students to use in pediatric nursing practicums by applying the analysis, design, development, implementation, and evaluation (ADDIE) model [21].

This study followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) reporting guidelines [22].

2. Analysis

To investigate the demand for child nursing VR practice

education, in-depth interviews were conducted with a learner group consisting of six students (four nursing students with practice experience in a children's ward and two graduates, <1 year after graduation), and an expert group consisting of four members (one nurse in the children's ward and three child nursing clinical practice faculty members). This convenience sample was obtained from July 1, 2021 to July 31, 2021. The number of interviewees was set at 10 based on a previous study [23] that qualitatively analyzed educational needs among 5 to 10 participants. After the researchers explained the purpose, method, and procedure of the study to the prospective participants, research assistants obtained written consent for participation in the study and for the recording of interviews. Group interviews of the nursing students, graduates, and expert nurses were also conducted.

Face-to-face interviews were conducted in the researchers' office to provide participants with a quiet and comfortable atmosphere. Due to the spread of coronavirus disease 2019 and in accordance with quarantine guidelines, if a face-to-face interview was not feasible, the interview was carried out by phone or through the video conferencing service Zoom at a convenient time in a quiet environment. To identify the demand for child nursing VR practice education, an unstructured in-depth interview was conducted based on the relevant literature and the researchers' experience. The same questions were asked to nursing students, graduates, and expert nurses. The main interview questions were as follows: 1) "Tell us about the important content or topics addressed during nursing practicums in the children's ward," 2) "Tell us about the difficulties students confront while practicing in the children's ward," 3) "Tell us about the preparatory content or topics you expect the school to provide before starting a practicum in the children's ward," 4) "Tell us about a suitable topic or content for developing VR programs that can be useful for nursing students," and 5) "Tell us about ways to increase students' interest in or motivation to participate in VR programs". The in-depth interviews each lasted approximately 30 minutes. The contents of the interviews were recorded and later transcribed for analysis.

3. Design

Based on the learning goals of child nursing [24], a literature review [25,26], and the in-depth interview results, the learning topics for the VR program for pediatric nursing practicums were selected, and the learning goals were determined. The learning goals and content were agreed upon and finalized by the three child nursing professors and the three experts who participated in the demand survey.

4. Development

As shown in Figure 1, the VR program for pediatric nursing practicums was developed according to the stages of planning, production, revision, and completion. In the planning stage, data were collected to create a storyboard. In the production stage, 360-degree filming was done to implement the VR, and then 15-minute VR content segments were produced through mixing. Based on the opinions of the three experts and three learners who participated in the demand survey regarding content, design, and usage, the final content was developed.

5. Implementation

The VR program was implemented to 20 nursing students who were in their third or fourth year at a nursing university located in Seoul, Korea. This convenience sample was obtained from November 1, 2021 to December 10, 2021, and included the group of four experts (one child ward nurse and three child nursing clinical practice faculty members) who had participated in the demand survey. Potential participants were made aware of the purpose, methods, and procedures of the study, as well as the fact that their involvement in it and their responses to the survey would not affect their evaluation or academic grade. They were also informed that they could stop at any time and that not participating would not put them at a disadvantage. They were also informed that following the study, the data will be deleted, protecting their privacy and confidentiality. Research assistants obtained their written consent to participate in the research. The total participation time in the VR program was 30 minutes: 15 minutes on neonatal vital signs and 15 minutes on young children's (25 months) vital signs.

6. Evaluation

The program was evaluated by the 20 nursing students and four experts who participated in the VR program. The number of subjects for program evaluation was set at 20 based on a previous study [27], in which 15 nursing students evaluated a practical education application. The nursing students were surveyed to assess their satisfaction with practice as well as their overall satisfaction with the VR program. The experts were surveyed for overall satisfaction with the VR program. The response times were 10 to 20 minutes.

1) Satisfaction with practice

The nursing students' satisfaction with practice was measured using the satisfaction of practice tool used by Ko and Jung [27], which consisted of 17 questions. Each question was scored using a 5-point Likert scale, with higher scores indicating higher practice satisfaction. In the study by Ko and Jung [27], Cronbach's α was 0.89, and in the current study, Cronbach's α was 0.90.

2) Satisfaction with the VR program

Satisfaction with the VR program among nursing students and experts was assessed using the 20 questions (9 questions on content and 11 questions on interface design) from Ko and Jung [27]. Each question was scored using a 5-point Likert scale, with higher scores indicating higher levels of satisfaction. In the study by Ko and Jung [27], Cronbach's α was 0.83 and, in the current study, Cronbach's α was 0.93.

3) Data analysis

Survey data were expressed as mean and standard deviation using SPSS version 24.0 (IBM Corp.).
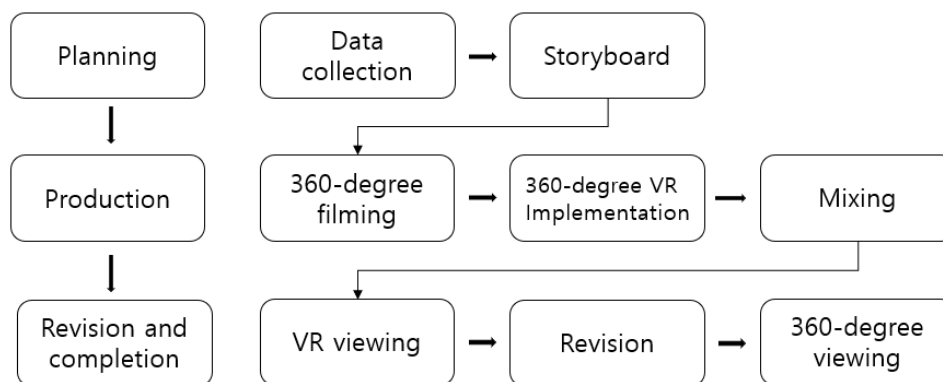

Figure 1. The process of manufacturing the contents of a VR program for a pediatric nursing practicum. VR, virtual reality.

RESULTS

1. Analysis

Based on the in-depth interviews with the six participants in the learner group and the four participants in the expert group on the demand for child nursing VR practice education, the demand for content development in measuring children's vital signs was high. Measuring children's vital signs was included in the answers to all questions about the important and difficult aspects of practicing in the children's ward, what participants expected the school to teach before practicums, and the recommended subjects for the VR program (Table 1).

The interviews revealed that nursing students had difficulty taking vital signs (which are measured frequently in the children's ward) because, unlike adults, children are not cooperative. In addition, different measurement methods and normal ranges are utilized based on age. The students were also not competent in forming relationships with the parents, which are needed to inspire trust and gain their support. Therefore, they requested a VR program for measuring children's vital signs in an environment like a real hospital.

> What we mainly did in the children's ward nursing practice was measure vital signs, but since children often cry, it was difficult to measure their pulse or respiration. I was confused because I heard a mix of lung sounds and heart sounds. In addition, there were many cases where the child burst into tears when I approached, and it was difficult to communicate with parents because they often did not trust me. (Learner 1)

> I had difficulty with the methods of measuring vital signs. It felt difficult because the patterns of children were different from those of adults and the measurement method was unfamiliar. (Learner 2)

> I had never measured a child's vital signs before and it was difficult to do because the child moved a lot and there was a big difference in body temperature depending on the measurement site. (Learner 4)

> It is important to measure the pulse quickly and instantly, but at first it was difficult to distinguish the pulse from respiration, and many children did not like the stethoscope when it was placed on their bodies. (Learner 5)

> It would be very helpful if there was content on how to accurately measure a child's vital signs and how to form rapport with the parents. (Expert 2)

> I hope they develop content on how to measure vital signs, how to distinguish between crying and pulse sounds when a child cries, how to communicate with a child, and how to treat a caregiver. (Expert 4)

2. Design

Based on the learning objectives of pediatric nursing [24], a literature review [25,26], and the in-depth interview results, the measurement of children's vital signs was selected as the learning topic for the VR program for pediatric nursing practicums. Blood pressure was not measured in this study because the subjects were children under the age of three, in whom blood pressure is not typically monitored [25].

The learning goals for the children's vital signs VR program were as follows: 1) the ability to accurately describe the child's

Table 1. Survey to Determine the Need for a Virtual Reality Program in a Pediatric Nursing Practicum

Question	Answer	
	Learner group	Expert group
Tell us about the important content or topics addressed during nursing practicums in the children's ward	Vital signs measurement, communication, rapport with parents	Vital signs measurement, how to use medical devices
Tell us about the difficulties students confront while practicing in the children's ward	Vital signs measurement, communication, how to use electronic medical records	Vital signs measurement, communication, how to approach the child patient
Tell us about the preparatory content or topics you expect the school to provide before starting a practicum in the children's ward	Vital signs measurement, medications, how to use the electronic medical records	Vital signs measurement, medications, information on devices and items used in hospitals
Tell us about a suitable topic or content for developing VR programs that can be useful for nursing students	Vital signs measurement, clinical experiences in a hospital setting, communication	Vital signs measurement
Tell us about ways to increase students' interest in or motivation to participate in VR programs	A realistic clinical setting, case study, feedback	Game-style contents, interactive operation, repetitive training, being included in pediatric nursing practicums

VR, virtual reality.

body temperature, pulse, and respiration; 2) the ability to accurately measure the child's body temperature, pulse, and respiration; and 3) the ability to accurately record the measurement results of the child's body temperature, pulse, and respiration.

To achieve the learning goals, two situations (a newborn patient model and a child patient model) were presented. The newborn model represented a baby boy with a birth weight of 3,300 g, born at 37 weeks and 5 days gestational age, through normal spontaneous vaginal delivery, and was staying with his mother in the same room. The child model represented a 25-month-old boy who had been treated at a local clinic for symptoms of runny nose, cough, and mild fever 1 week ago, but the symptoms had not improved. For the past 2 days he has had a high fever and productive cough. He was diagnosed with pneumonia in the outpatient clinic today and was hospitalized in the children's ward.

The VR content included the process of obtaining information and assessing the situation of the newborn and the child, preparing supplies, explaining the purpose and procedure to the caregivers at the bedside, measuring vital signs, and recording the measurement results.

3. Development

To create the VR program for pediatric nursing practicums, we developed practical education content for the measurement of neonatal and child vital signs as well as an evaluation system. A storyboard for the measurement of vital signs in newborns and children was drawn up, and 360-degree VR filming was implemented. In addition, it was designed to provide learners with necessary information in pop-ups, to record questions or explanations made between the virtual caregivers and the student during the practice, and to administer short quizzes. Based on suggestions from the three experts and three nursing students in the initial content survey, a watch was displayed on the hand washing screen image so that hand washing could be performed accurately, a watch with a second hand was presented at the top right of the screen to be seen clearly during vital sign measurement, and an actual newborn's abdominal breathing video was added when the newborn's respirations were measured. The final content screen was much like an actual clinical situation.

The developed program was made available on the university homepage (or its corresponding domain, vr.snjc.ac.kr) for the convenience of learners who could access the contents through a web browser (Chrome or Edge) on their personal computer or mobile phone. The contents were designed for learners to virtually experience the process of measuring body temperature, pulse, and respiration after confirming patient information and learning goals (Table 2, Figure 2).

Learners could check reference data while measuring vital signs, solve related quiz problems (multiple choice, input type, recording type), review whether the procedures had been performed correctly after completing the VR session, and check their quiz scores. Instructors could check each learner's correct/wrong answers, recorded data, execution time, and total score; download the score results as an Excel file; and write evaluations to provide feedback to each learner (Figure 2).

The devices and programs used to develop the VR program for pediatric nursing practicums were a 360 VR filming camera (RICOH THETA 360 5.7K; Ricoh Company Ltd.), a 360 VR video editing program (Insta360 Studio; Insta360), a 3D graphic engine program (3ds Max; Autodesk Inc.), and a content development engine program (Unity3D; Unity Technologies). We used VR practice education program software (GLOBEPOINT Inc.) according to the learning goals and content configured in the design stage of this study.

4. Implementation and Evaluation

The average age of the nursing students who participated in the VR program was 24.1±3.3 years, and all were women. Ten students were in their third year and 10 were in their fourth year. Three (15.0%) had practice experience in the children's ward, whereas 17 (85.0%) did not. The average age of the experts was 45.5±8.1 years (39-57 years), the average experience working in a children's ward was 10.0±12.0 months (16-24 months), and the average experience in serving as an instructor for child nursing practice was 4.5±1.0 semesters (4-10 semesters).

The average satisfaction with practice among nursing students was 4.02±0.56 points, and the average satisfaction with the VR program was 4.15±0.54 points. The overall satisfaction with the contents of the VR program was 4.16±0.63 points, with 4.25±0.64 points for understanding, 4.15±0.87 points for accuracy, and 4.11±0.25 points for objectivity. The overall satisfaction with the interface design of the VR program was 4.14±0.53 points, with 4.43±0.47 points for vocabulary accuracy, 4.26±0.68 points for consistency, and 3.90±0.66 points for compatibility.

The experts' satisfaction with the VR program averaged 4.79±0.07 points, and all subcategories of satisfaction with the contents of the VR program (accuracy, understanding, and objectivity) averaged 5 points. The overall satisfaction with the interface design in the VR program was 4.59±0.15 points, with 4.83±0.33 points for vocabulary accuracy, 4.58±0.50 points for consistency, and 4.45±0.44 points for compatibility (Table 3).

Table 2. Contents of the Virtual Reality Program for Vital Sign Measurement in Infants and Children

Categories		Contents
Login		ID, password
Patient information		Name, sex, age, body weight, medical diagnosis, chief complaint
Learning objectives		I can accurately explain the body temperature, pulse, and respiration of a child I can accurately check the body temperature, pulse, and respiration of a child I can accurately record the body temperature, pulse, and respiration of a child
Practical items		Stethoscope, thermometer, alcohol swabs, hand disinfectant, watch
Procedures	Washing hands	Wash hands using water and soap Quiz: multiple choice
	Preparing items and checking their operation	Quiz: choosing items
	Introducing myself	Voice record
	Washing hands	Wash hands using disinfectant Quiz: multiple choice
	Explaining the purpose and procedure of measuring vital signs	Voice record
	Patient identity verification	Voice record
	Positioning	Supine position
	Disinfecting a thermometer	
	Checking body temperature	Newborn baby: axillary temperature Young child: tympanic temperature Quiz: how to check the tympanic temperature
	Recording body temperature	Documenting in the medical record
	Disinfecting and warming a thermometer	
	Checking the apical pulse	Check the apical pulse Quiz: how to check a newborn baby's pulse; region of the apical pulse Pop-up information: normal pulse rates
	Recording apical pulse	Documentation in the medical record
	Checking the respiratory rate	Newborn baby: check abdominal movements Young child: auscultate respiratory sounds Pop-up information: normal respiratory rates, video clip of newborn baby's abdominal breathing
	Recording the respiratory rate	Documentation in the medical record
	Disinfecting items and storing or disposing of them	
	Washing hands	
Evaluation		Correct answers and incorrect answers, feedback

DISCUSSION

The highest-demand topic among the learners and the experts was the development of a VR program focused on the measurement of children's vital signs. Therefore, the measurement of vital signs in newborns and children was selected as the learning topic for the VR program for pediatric nursing practicums. This is consistent with the results of a previous study [28], in which the highest level of educational needs among nursing students during their neonatal nursing practice education was found for the category of newborn assessment and the item of vital signs.

As nurses should be able to quickly detect health problems in children, learning how to accurately assess children's

Main screen			-
Patient information			-
Learning objectives			-
Washing hands			-
Preparing items/ introducing myself			-
Checking body temperature			
Checking the apical pulse			

Figure 2. The virtual reality program for vital sign measurement.

Figure 2. The virtual reality program for vital sign measurement (continued).

health is an important learning goal in pediatric nursing [24]. Vital signs, including body temperature, pulse, and respiration, are indicators of the physiological state of vital functions and should be accurately measured and compared with normal values according to age. As children grow, their body proportions and cardiorespiratory function change, so the normal ranges of body temperature, pulse rate, and respiration differ according to age, and the measurement methods also differ [25]. It is critical to be attentive and to accurately evaluate the physiological condition of newborns as they experience changes in gas exchange from the placenta to the lungs; closure of the fetal ductus arteriosus, foramen ovale, and ductus venosus; and major changes in blood circulation [29]. It is

essential for nursing students to perform basic techniques such as the measurement of vital signs during child nursing practicums [28]. If nursing students only observe other nurses in clinical practice and do not practice for themselves, they will not be able to perform the work skillfully when they become nurses [30]. Therefore, our VR program was constructed to allow nursing students to practice vital sign measurements that nursing performance need is high in a realistic VR space.

In our VR program, a student logs in with an identification badge and a password, then patient information and situations are introduced. Learning goals and necessary items are then presented so that the student can monitor their nursing performance status and check their learning goals. Accurately

Table 3. Satisfaction Survey for Virtual Reality Practice and for the Vital Sign Measurement Virtual Reality Program (*N*=24)

Categories	Nursing students (n=20)	Experts (n=4)
	M±SD (range)	M±SD (range)
Satisfaction with practice	4.02±0.56 (1-5)	
Satisfaction with virtual reality program	4.15±0.54 (1-5)	4.79±0.07 (4-5)
Contents	4.16±0.63 (1-5)	5.00±0.00 (5)
Accuracy	4.15±0.87 (2-5)	5.00±0.00 (5)
Understanding	4.25±0.64 (1-5)	5.00±0.00 (5)
Objectivity	4.11±0.25 (1-5)	5.00±0.00 (5)
Interface design	4.14±0.53 (2-5)	4.59±0.15 (3-5)
Consistency	4.26±0.68 (2-5)	4.58±0.50 (4-5)
Compatibility	3.90±0.66 (2-5)	4.45±0.44 (3-5)
Vocabulary accuracy	4.43±0.47 (4-5)	4.83±0.33 (4-5)

M, mean; SD, standard deviation.

assessing the situation and meeting self-defined learning goals motivates the student to continue learning [31].

Hand hygiene is very important in child nursing because the risk of infection transmission is high in newborns and children due to their immature immune systems [25]. In our VR program, students first wash their hands with soap and water, prepare items, go to the patient, wash their hands with hand sanitizer, measure vital signs, dispose of used items, and finally wash their hands again. Hand hygiene requires repeated training, and this VR program allows students to practice and fully learn it.

In this VR program, students were required to confirm the identity of the newborns and children by asking their caregivers, verbally explain the purpose and procedure for measuring vital signs, and record the results for evaluation. Nursing students often find communicating with patients or caregivers in clinical practicums stressful and can also find it difficult to accurately explain the purpose and procedures of nursing activities [4]. The VR program provides opportunities for students to communicate with their virtual patients' caregivers and correct their weaknesses by listening to the recorded communication. Through these exercises, nursing students can gain confidence in meeting and communicating with real patients or caregivers in real clinical settings.

Unlike the pulse and respiration rates of adults, those of newborns and children are fast and irregular, so nursing students can experience difficulties when measuring the vital signs of newborns or young children for the first time. In the VR program developed in this study, the nursing students listened to the actual breath sounds and heart sounds of newborns and children and watched images of abdominal movements so that they could practice in a realistic situation. The safety of patients is not threatened when VR programs are

used because nursing practice is performed on virtual newborns and children in a VR space, not on real newborns and children who are vulnerable to infection during repeated contact with nursing students. Nursing students can learn basic and important nursing skills through repeated training in the VR program with the goal of safely and skillfully nursing patients when they graduate [12].

Clinical scenarios can be implemented and practiced in traditional simulations using manikin simulators and clinical practice faculty. However, since many students practice on a limited number of manikin simulators in a limited space at a fixed time, the practice time given to each individual is not long. Since simulation in the lab is conducted as a team rather than as individuals, due to limitations in instructional personnel and physical resources, the opportunity to learn nursing skills is relatively reduced [20]. The clinical practice faculty who lead the simulations as facilitators can also have unintended differences when they teach, depending on the session [32]. Our VR program overcomes these physical limitations and provides a consistent procedure to all students so that they can become proficient in measuring vital signs by repeatedly listening to the breathing and heart sounds of newborns and children and repeatedly measuring body temperature.

In this study, the VR program was designed to increase student immersion by providing students with necessary information in pop-ups and by administering quizzes. In addition, after completing the VR program, the students could check their performance on procedures and quizzes so that they could improve through feedback. The instructors also wrote evaluation reports for each learner. Applying newly acquired knowledge and skills to quizzes and practice sessions, plus receiving feedback on their responses, increased learners' motivation and satisfaction [31].

Solidification of newly developed programs through usability tests and feedback is important to the success of a program before applying it to the educational field [9]. Therefore, we asked for feedback on the contents, design, and usability of the preliminary VR program from nursing students and experts, and assessed their satisfaction with the final VR program. In this study, the average satisfaction with practice among the nursing students was 4.02 points on a 5-point Likert scale which was lower than the score of 4.71 points found in a former study [27], and the average satisfaction with the VR program was as high as 4.15 points. In addition, experts' satisfaction with the VR program averaged 4.79 points, which was higher than that of the learner group. It may be inferred that students had higher expectations than professionals.

In summary, the VR program for pediatric nursing practicums that was developed in this study will be used by nursing students to practice measuring infant and children's vital signs and will contribute to achieving the goals of child nursing practice and increasing nursing students' clinical competence. This study will also contribute to the advancement of nursing research and theory in the field of VR.

However, there are a few limitations of this study. It was conducted using convenience sampling among students enrolled at one nursing college, so caution should be used when interpreting and generalizing the study results. In addition, since this study was done for development of a VR program to measure vital signs in children, the nursing students' satisfaction with practice was assessed after they participated in the VR program. Future research evaluating the VR program should assess nursing students' performance and confidence in measuring vital signs in children. The satisfaction score for compatibility in the interface design area of the developed VR program was relatively low. Thus, the limitation of our VR program is that it is not completely realistic, despite our efforts to implement the VR in a realistic form. As well, because digital technology cannot be utilized to gain knowledge and skills on its own, qualified faculty and proper equipment should be used. In the future, technical improvements and faculty training are needed to increase VR compatibility. Since nursing education benefits from both VR-applied simulations and simulations that use high-fidelity manikins [33], studies should be conducted that apply both methods to effectively utilize their characteristics and advantages in simulation training.

CONCLUSION

This study was conducted to develop a VR program for pediatric nursing practicums using the ADDIE model. This study identified the need for a VR program for nursing students, and determined the topic, learning objectives, and con-

tents of the VR program. The content of the VR program for pediatric nursing practicums was developed to include the vital sign measurement of a newborn baby and a young child, as well as an evaluation system. The nursing students and experts who used the developed program were highly satisfied. The VR program developed in this study will strengthen nursing students' clinical capabilities when used in pediatric nursing practicums and will effectively contribute to attaining the learning objectives of pediatric nursing practicums.

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Authors' contribution

Conceptualization: Sun Nam Park, Hyun Young Koo; Data collection, Formal analysis: Hye Young Hwang, Hyun Young Koo; Writing-original draft: all authors; Writing-review and editing: all authors; Final approval of published version: all authors.

Conflict of interest

Hyun Young Koo has been an editor of *Child Health Nursing Research* since 2016. She was not involved in the review process of this article. No existing or potential conflict of interest relevant to this article was reported.

Data availability

Please contact the corresponding author for data availability.

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