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The effect of virtual reality education using VSIM for nursing students

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***Abstract*---**The purpose of this study is to confirm the effectiveness of the problem solving process, critical thinking disposition, and self-directed learning ability effect between the group who received virtual reality simulation training online for 3rd grade nursing students and the group who received clinical practice training offline for them. The experimental group (18 people) was asked to evaluate patient care and provide feedback through VSim Scenarios (The National League for Nursing & Laerdal Medical), an online interactive virtual simulation. The control group (19 people) was given offline regular practical training. Data analysis was using SPSS25.0. As a result of the study, it was found that the experimental group who received virtual reality simulation practical education using online had a significantly higher problem solving process (Z=-2.194, p=.028) than the control group. Processes such as patient safety, communication, physical assessment, and drug injection appear to have had a positive effect on solving the problem by providing patient information through scenario learning, pre-learning quizzes, and providing feedback to patients after nursing in a virtual simulation space. In conclusion, in order to confirm the effectiveness of online virtual reality simulation education, it is necessary to continuously study by applying various variables. Also, it is suggested to plan and operate an online education program so that students can practice based on clinical situations in a realistically safe environment.

Keywords*---virtual reality, simulation, nursing, practice, education.*

Introduction

The goal of nursing curriculum emphasized the importance of theory and practical education. Nursing education institutions are making efforts to improve the student's performance skills by identifying patient situations and solving

health problems through clinical practice education for their knowledge gained from theory (Kim et al., 2012). In the nursing curriculum, practical training in the clinical field is essential to improve the practical skills of students and to build their professional literacy (Jun et al., 2012). Currently, practical training is being conducted mainly in medical institutions, but observation-oriented practice is being conducted due to the shortage of training hospitals and the problem of patient safety (Kang et al., 2020).

The recent spread of Corona 19 has changed the university education environment to online and offline, and emphasized the activation of online education by emphasizing untact and ontact (Kang 2020). In particular, nursing education institutions suffered for difficulties as training was completely stopped for the prevention and safety of infection control for patients and students, and all medical institutions were unable to receive trainees due to fear of possible safety accidents during training (Oh 2020). Accordingly, most schools recognized the difficulty of clinical practice and began to replace it with online practice, emphasizing the need for efficient practice (Lim et al., 2020).

Students participating in practical education are experiencing observation-oriented clinical practice, so they generally have low satisfaction with the practice and lack of experience in skill performance (Kang 2020). This phenomenon is acting as a factor that determines the job change to unable adapting to the environment when new nurses adapt to the new organization of hospitals after graduating from college and are exposed to various problems such as new human relationships, excessive work, and inexperienced knowledge & skills. Therefore, as a professional nurse, the ability to judge the nursing situation, the process to solve problems in nursing intervention, and the ability to make self-regulating judgments are very important as factors for adapting to the clinical environment (Hong 2021).

Simulation-based learning is one of the educational strategy methods that can replace clinical practice. This includes discussion, self-reflection, and questions so that learners interact to immerse themselves in the learning environment and actively participate in the learning process (Kriz 2010). In addition, the debriefing process based on various scenarios has the advantage of solving problems according to the nursing situation, cultivating critical thinking skills, and experiencing opportunities that cannot be obtained in the clinical field safely. However, the environmental system requiring expensive equipment, the need for active participation of students while running the simulation, and the burden that students feel for mistakes etc (Aebersold 2018) were raised as practical problems in applying simulation education. As the technology of information and communication has advanced, it has faced a new phase even in the change in the educational environment (Jeon 2018).

Virtual reality simulation is emerging as an educational method that replaces simulation that requires expensive equipment (Kim et al., 2019; Ju et al., 2020). It is used as the name of virtual simulation, computer-based simulation and web-based simulation etc (Foronda et al., 2014). Virtual reality simulation education is a method that learners themselves use computer programs without being affected by time and place, so it is possible to repetitively self-learn and provide feedback

on the execution process. As a result, it is reported that there is no burden for mistakes, which has a positive effect on improving confidence (Gordon et al., 2014). In addition, it is increasingly used in the field of nursing because it simulates a virtual environment and experiences learning activities through the application of scenarios based on nurse cases and online methods using computer software (Leibold et al., 2017). In studies using virtual reality simulation for nursing students, and foreign studies, it was found that it had a positive effect on communication, teamwork, decision making, and knowledge acquisition (Peddle et al., 2016). In a domestic study, it was reported that self-efficacy, problem solving process, critical thinking tendency, clinical performance ability, and self-confidence improved in relation to asthma child care (Kim et al., 2019; Ju et al., 2020; Foronda et al., 2014) and acute heart disease care (Chu et al., 2017; Kim et al., 2018; Choi 2020).

Currently, scenarios used in various educational programs are being developed and their effectiveness verified, but the situation is insufficient.

Accordingly, this researcher aims to provide effective basic data for practical training methods by comparing the effectiveness of virtual reality simulation education using online and clinical practice education applied offline, and reviewing the utilization plan of virtual reality simulation education while difficulties in clinical practice due to Corona-19.

Research Method

Research Design

This study used the pre- and post-similar experiment design of a nonequivalent control group to evaluate the difference between the effect of online virtual reality and offline clinical practice education on health assessment for nursing college students.

Research Subject

The subjects of this study were 3rd grade nursing students at a university located in G city, who did not have experience in online virtual reality simulation education and offline clinical practice. Using G*power program to select the number of samples, the number of subjects for mean comparison (t-test) of the two groups was calculated as significance level .05, power .80 and affect size 0.8. Finally, the number of subjects in each group was 14. The subjects of this study recruited students from the school to which the researcher belongs because clinical practice was difficult and there was no control group applying a similar curriculum in relation to COVID-19. The final subjects were 37 who agreed to participate in the study by signing the consent form. The final experimental group was 19 and the control group was 18. Each group consisted of 14 or more subjects, and data were collected from more than the selected sample.

Research Instruments

Problem Solving Process. The tool developed by Lee, Park and Choi (Lee et al., 2008) was used. It consisted of a total of 30 questions in 5 areas: 6 questions for clarifying the problem, 6 questions for finding solutions, 6 questions for decision making, 6 questions for applying solutions, and 6 questions for evaluation & reflection. Each question is a 5-point Likert scale and score is 30~150 points, and the higher the score, the higher the problem-solving process. The Cronbach's a value of the tool was .93 in the study of Lee et al [24], and .929 in this study.

Critical Thinking Disposition. The tool developed by (Yoon 2008) was used. The research tool consists of 27 questions in 7 areas. Each question was scored from 1 point of 'not really' to 5 points of 'really' on a 5-point scale, and negative questions were inverted, and the higher the score, the stronger the critical thinking disposition. The Cronbach's a value of the tool was .84 in the study of (Yoon 2008) and .874 in this study.

Self-Directed Learning Ability. The tool developed by (Lee et al., 2003) was used to measure Self-directed learning ability. It consisted of a total of 45 questions: 20 questions for the 'learning plan', 15 questions for 'learning execution', and 10 questions for the 'learning evaluation'. Each question is a 5-point scale. Negative questions were inverted, and the higher the score, the stronger the self-directed learning ability. The Cronbach's a value of the tool was .93 in the study of (Lee et al., 2003) and .933 in this study.

Online Virtual Reality Simulation Scenarios
The online virtual reality simulation scenario used the health assessments of the nervous system, skin system, and muscle system provided by Leardal Medical and Wolters Kluer.

Data Collection Methods and Procedures

This study was conducted with the data collected from June 8 to June 14, 2020. After the researcher directly explained the method of study to the subject, it was targeted to those who agreed. It was explained that it is possible to withdraw at any time if not desired, and that there will be no disadvantages, and that the data are used only for pure research purposes, and that all personal matters are statistically processed anonymously and confidentiality is guaranteed. Participants were provided with a small gift in return.

Preliminary Investigation

In order to verify the homogeneity between the two groups, a questionnaire to evaluate general characteristics, problem solving process, critical thinking disposition, and self-directed learning ability was distributed and surveyed before experimental treatment.

Experimental Treatment

The experimental group experienced online virtual reality simulation training for a week from Monday to Friday, and the control group experienced offline clinical practice training for a week from Monday to Friday.

Online Virtual Reality Simulation Training

For the operation of online virtual reality simulation education, teachers access the homepage related to the use of vSim for Nursing and then register for the class first, and the students are required to watch the orientation video upload by the instructor on the learning management system. The content of the orientation is the overall part where students must log in to the homepage and perform assignments. After having students enter the class code, they were guided to check the contents of the simulation scenario. In particular, it was instructed to check patient information, pre-simulation quiz, vSim, post-simulation quiz, assignments, and debriefing process.

In order to apply the same operating hours as offline clinical practice, the reason for selecting a virtual reality simulation scenario through pre-orientation, assignments, and journal writing etc were explained. In addition, progress is operated in the order of 'Suggested reading' [Provide patient information necessary for simulation learning preparation], 'Pre-simulation quiz' [Confirm learner's preliminary preparation for the efficient operation of scenario], 'vSim' [Provide nursing care(physical assessment, communication, drug injection, patient safety check erc) to the patient in a virtual simulation space similar to the clinical site], 'Post-simulation quiz' [Confirm knowledge related to scenarios after simulation ends], 'Documentation assignments' [Present assignments for scenario-related patient information and nursing intervention], 'guided reflection questions' [Review and Confirm of learning contents after simulation experience].

In order to grasp the progress of the nursing students step by step, a real-time chat room was created using a mobile phone to provide feedback. The five-day practice operation was based on the neurocognitive, skin, abdominal, and musculoskeletal assessment scenarios. During the scenario study, nursing students took a quiz in the section to check their pre/post knowledge, then sorted out incorrect answers and made important matters referenced in the textbook. The evaluation result score was continuously manage to reflect the improved score through repetitive learning by setting a standard of at least 90 points. Nursing students were asked to write a practice journal for each scenario. After having nursing students select one scenario, apply the nursing process, and present them, individual feedback was provided, and it took about 15 minutes per person.

Offline Clinical Practice Training

Offline clinical practice training was conducted from Monday to Friday in the surgical ward of C University Hospital in G City. On the first day, nursing students were asked to check the subject (patient) information for each individual

and select the subject for case study. At the 2nd day, the clinical practice staff visited the ward and instructed them to apply the nursing process such as nurse administration, diagnosis, planning, intervention, and evaluation. At the 3rd to the 4th day, nursing students were asked to complete 4 nursing courses through observation and medical records of the subject. On the 5th day, the written nursing course was announced for about 15 minutes for each student, and individual feedback was provided for about 5 minutes after the presentation.

Data Analysis

The data was analyzed using the SPSS 25.0 statistical program, and the analysis method is as follows. The general characteristics of the pre-homogeneity verification of the two groups was analyzed as chi-square test and Mann-Whitney according to the characteristics of the variables. Mann-Whitney analyzed the comparison of pre-homogeneity verification and difference between the two groups.

Research Result

Homogeneity Test

Homogeneity Test for General Characteristics. As a result of analyzing the homogeneity of the experimental group and the control group for general characteristics according to age, sex, academic achievement, major satisfaction, job hope, and personality, there was no significant difference between the two group($p > .05$), so homogeneity was confirmed between the two groups(Table 1).

Table 1
Homogeneity Test of General Characteristics between Groups (N=37)

Variables	Categories	Exp.(n=18) n (%) or M±SD	Cont.(n=19) n (%) or M±SD	Z or x^2	*p*
Age(yr)		24.11±3.60	23.84±2.95	-0.282	.799
Gender	Male	0(0.0)	1(5.3)	0.974	1.000
	Female	18(100.0)	18(94.7)		
GPA	2.0≤~<3.0	1(5.6)	3(15.8)	3.399	.355
	3.0≤~<3.4	4(22.2)	7(36.8)		
	3.5≤~<4.0	44(61.1)	6(31.6)		
	4.0≤	2(11.1)	3(15.8)		
Admission motivation	Considered employment	8(44.4)	10(52.6)	1.544	.505
	With aptitude	8(44.4)	5(26.3)		
	Encouragement by parents or other	2(11.1)	4(21.1)		

Satisfaction with major	Very satisfied	6(33.3)	2(10.5)	3.064	.463
	Satisfied	6(33.3)	7(36.8)		
	Fair	5(27.8)	8(42.1)		
	Unsatisfied	1(5.6)	2(10.5		
	Very unsatisfied	0(0.0)	0(0.0)		
Job-hope	Advenced hospital	13(72.2)	9(47.4)	4.860	.298
	General hospital	2(11.1)	6(31.6)		
	Hospital	1(5.6)	1(5.3)		
	Health teacher	0(0.0)	2(10.5)		
	Public health nurses	2(11.1)	1(5.3)		
Personality	Extrovert	6(33.3)	4(21.1)	0.788	.747
	Introvert	3(16.7)	4(21.1)		
	Mixed	9(50.0)	11(57.9)		

**p>0.5*

Homogeneity Test for Dependent Variable. In order to analyze the difference of the two groups before education, the results of the Mann-Whitney analysis showed no significant difference (p >.05), confirming the homogeneity of the two groups. (Table 2).

Table 2
Test for homogeneity of the dependent variable between two groups (N=37)

Variable	Exp.(n=18)	Cont.(n=19)	Z (*p*)
	M±SD	M±SD	
Problem solving process	3.64±0.37	3.78±0.48	-.867(.391)
Critical Thinking Disposition	3.61±0.35	3.78±0.44	-1.323(.189)
Self-directed Learning	3.48±0.57	3.68±0.72	-1.201(.233)

Difference Test

Comparison of Dependent Variables Before and After Practice Training in Two Groups. As a result of comparing the differences between the two groups before and after education, the online virtual reality simulation education group had a problem solving process (z=-3.764, p<.001), critical thinking disposition (z=-3.444, p=.001), and self-directed learning ability(z=-3.403, p=.001), the score increase

after education was statistically significant compared to before education. In the offline clinical practice education group, scores increased after education, but there was no statistically significant difference (Table 3).

Comparison of Dependent Variables after Practice Training in Two Groups. There was a significant difference in the problem-solving process as a result of conducting a difference test after training between the two groups(Table 4).
The problem-solving process was out of 5 points, and was an average of 4.16 points(S.D.=0.332) for the experimental group and 3.84 points(S.D.=0.457) for the control group. The critical thinking disposition was out of 5 points, and was slightly higher in the experimental group(3.88 points ± 0.301) than the control group(3.86 points ± 0.512), but not statistically significant. The self-directed learning ability was out of 5 points, and was slightly lower in the experimental group(3.70 points ± 0.634) than the control group(3.71 points ± 0.644), but not statistically significant.

Table 3
Comparison before and after education between the two groups (N=37)

Variable	Exp.(n=18)			Cont.(n=19)		
	pre M±SD	post M±SD	Z (*p*)	pre M±SD	post M±SD	Z (*p*)
Problem solving process	3.64±0.37	4.16±0.33	-3.764 (<.001)	3.77±0.48	3.84±0.46	-.983 (.326)
Critical Thinking Disposition	3.61±0.35	3.88±0.30	-3.444 (=.001)	3.78±0.43	3.86±0.51	-.807 (.420)
Self-directed Learning	3.47±0.57	3.70±0.63	-3.403 (=.001)	3.68±0.72	3.71±0.64	-.109 (.913)

p <.05

Table 4
Comparison after education between the two groups (N=37)

Variable	Exp.(n=18) M±SD	Cont.(n=19) M±SD	Z (*p*)
Problem solving process	4.16±0.33	3.84±0.46	-2.194(.028*)
Critical Thinking Disposition	3.88±0.30	3.86±0.51	-.396(.692)
Self-directed Learning	3.70±0.63	3.71±0.64	-.106(.915)

p <.05

Discussion

This study attempted to confirm the effect of the educational method between online virtual reality simulation education and offline clinical practice education.

First, as a result of analyzing the problem-solving process, critical thinking disposition, and self-directed learning ability before and after education in the online virtual reality simulation education group, it was confirmed that statistically significant improvement after education compared to before education. In the case of problem solving process and critical thinking disposition, the results were similar to those of a study applying virtual reality simulation of asthma child care for nursing students (Kim et al., 2019; Ju et al., 2020) and a study applying web-based simulation for acute heart disease patients (Choi et al., 2017). In the case of the self-directed learning ability, the results were similar to those of a study that web-based learning is a positive factor because it induces active participation of learners and provides scientific and systematic learning contents to meet learners' speed (Kim 2003). The process of repetitive learning in a stable space and confirming feedback on the result by helping online virtual reality simulation to experience various clinical scenarios (Ha et al., 2021) would have been a factor that had a great influence on learning motivation and self-directed learning ability. In particular, the study that learning motivation and self-directed learning ability acted as positive influencing factors on problem-solving ability (Kang et al., 2016) supports the results of this study.

Second, as a result of analyzing the problem-solving process, critical thinking disposition, and self-directed learning ability before and after education in the offline clinical practice education group, the scores improved after education compared to before education, but there was no significant difference. These results are judged to be suitable because third graders in the nursing department curriculum should experience and share actual cases through clinical practice courses to develop problem-solving ability (An 2007), but subjects of this study conducted patient observation and nursing intervention for a short period of time since the regular clinical practice period was only about 5 days due to COVID-19. In addition, clinical practice training enables nursing students to acquire knowledge and skills so that they can cope with various clinical situations to perform nursing (Kim et al., 2012). Since most of the direct nursing practice of nursing students is observation-oriented practice as the level of nursing service and the awareness of the rights to the safety of the nursing subjects increase (Lee et al., 2011), it is inevitable that it is difficult to make decisions according to the situation and provide appropriate nursing through clinical practice. When planning an operation plan for practical training, it is necessary to consider the practice time and apply various teaching methods. In particular, students should efficiently operate simulation classes to solve nursing problems and improve critical thinking skills. It would be important to plan to have feedback time after the practice (Shin et al., 2017; Wei et al., 2019). It is believed to be necessary to consider this for the efficient operation of the practical training.

Third, as a result of comparing the problem-solving process, critical thinking disposition, and self-directed learning ability according to the practice training method of the online virtual reality simulation education group and the offline clinical practice education group, problem solving ability was significantly higher in the experimental group that experienced virtual reality simulation than the control group, but there was no significant difference in critical thinking disposition and self-directed learning ability. These results are difficult to compare because there are no similar studies to this study, but online virtual

reality simulation that reflects various clinical environment scenarios affects students' motivation and enables them to solve problems with ease in a safe learning environment (Kim et al., 2019). These seem to have contributed to these results. In previous studies, it is said that critical thinking propensity is correlated with clinical performance capability (Chae 2019; Lee 2017). Therefore, based on the results of this study, repetitive studies are needed to apply programs to improve clinical performance ability and to confirm their effectiveness. In the case of self-directed learning ability, unlike the research results that had a positive effect when using web-based simulations (Ha et al., 2021), there was no significant difference. Since these results are judged to reflect learners' individual differences, a learning plan should be established in consideration of learners' level.

As discussed above, this study is considered meaningful because previous studies are insufficient to compare with the result of this study. Although continuous research is required in the future, online virtual reality simulation not only can efficiently utilize the learning time (Kim et al., 2015), but also facilitates repetitive learning, and can be combined with other teaching methods as blended education (Mckeon et al., 2009). This provides an environment in which medical personnel can develop their competencies through diverse and realistic experiences and serves as a driving force for continuing the educational effect of simulation (Park 2018). As the changes in learners and educational environments are progressing rapidly along with the 4th Industrial Revolution, the results of this study are expected to serve as basic data for exploring the ways to develop practical training and considering support for operation.

Conclusion and Suggestions

This study confirmed that before and after the online virtual reality simulation education and offline clinical practice education for nursing students, the problem-solving process, critical thinking disposition, and self-directed learning ability were improved. In particular, the group who received online virtual reality simulation training significantly improved later than before, and the comparison between the two groups showed that the problem-solving ability was significantly higher than the group who received offline clinical practice training. As a result, online virtual reality simulation education is a necessary part of the educational environment, which is made up of recent shortages of clinical practice hospitals and observation-oriented practice. Especially, it is necessary to check the effectiveness of education by applying it not only to nursing students but also to new nurses. In addition, it is necessary to develop a program that can maximize the effectiveness of the practice operation, such as developing various scenarios, applying online and offline blended teaching and learning methods, and expanding VR and AR education. Based on the above research results, I would like to make the following suggestions. To improve critical thinking disposition and self-directed learning ability, it suggests the development of an online virtual reality simulation curriculum program and iterative research various subject applications, and through variables. It suggests the development of the online virtual reality simulation curriculum program and iterative research through application of various subjects & variables.

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