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Effects of integrated simulation education among nursing students during the COVID-19 pandemic in Korea

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Abstract: *The purpose of this study was to analyze the effectiveness of integrated simulations conducted by virtual simulation and in situ simulation among nursing college students during COVID-19. This study was conducted from July 7 to 9, 2020 and the participants included 126 fourth-year nursing college students. Integrated simulation consisted of virtual simulation, teledebriefing, pre-briefing, in situ simulation, and debriefing. The results showed that after the use of various simulation modules and the training of integrated simulations incorporating virtual and in situ simulation training, critical thinking (t=5.20, p=<0.001), clinical judgment (t=6.71, p=<0.001), and simulation effectiveness (t=3.53, p=0.001). These findings could help establish the direction for more diverse forms of simulation-based education and it should be conducted in future nursing simulation during this COVID-19 pandemic era.*

Keywords: Simulation; Training; Students; Nursing; Integration; COVID-19

1. Introduction

In recent years, nursing education has emphasized clinical practices that can promote problem-solving skills to train professional nurses. It is more important to strengthen nurses' practical competency because learning takes place while transferring the knowledge acquired in theory through clinical practice into action. However, in clinical practice, as patients strongly resist becoming students' practice patient, and as the demand for patient safety increases, the chances for students to participate directly in various experiences diminish [1]. In addition, nursing students complain of ambiguous fear, anxiety, burden, depression, and lack of clinical practice in multiple studies, and report high stress, fatigue, and decreased self-esteem; therefore, supplements and alternatives are needed in situations where clinical practice is difficult [2]. In the recent COVID-19 pandemic situation which is penetrating the world, opportunities for clinical practice experience are limited, so a new challenge in nursing education has begun [3].

To solve these difficulties at present, various teaching-learning methods are being tried in the nursing education field, and research is being conducted to evaluate its effectiveness [4]. In particular, learner-centered training, such as problem-based learning, team-based learning, flipped learning, action learning, and simulation-based learning is being attempted in various ways. Learner-centered education encourages students to participate actively in learning in a cooperative and contextual environment to acquire knowledge through reflection. Among nursing students, learner-centered education can achieve knowledge acquisition, creativity, self-directed learning, communication skills, problem-solving, and critical thinking as learning outcomes [5].

In particular, simulation education used in nursing practice education enhances adaptability to the clinical field and implements a simulation situation similar to that of an actual practice situation, enabling the building of experience in clinical practice [6]. It is an educational technique that includes experiential learning through debriefings designed and facilitated with the aim of increasing the engagement of each learner and transferring knowledge, skills, and attitudes into a clinical setting [7]. In simulation education, various types of simulation education are being attempted, including using simulators showing the fidelity of several levels, using role-plays or trained standardized patients, or performing hybrid simulations by fusion. Through this simulation

education, students' self-confidence is known to increase through the improvement of active performance ability, subsequently improving problem-solving ability, team learning ability, and clinical performance [8].

Clinical judgment is critical to making important decisions in clinical practice, and this is an important foundation for clinical performance [9]. In simulation training, the clinical judgment process sometimes occurs within a simulation scenario, in some cases reflecting, exploring and experiencing a given clinical situation and one's own performance during the debriefing process. These courses allow students to train themselves in the process of integrating judgment, decision making, and performance in a clinical setting. Through this experience of simulation, students gain experience and confidence in learning, which is evaluated as the effect of simulation [10]. In addition, critical thinking has been reported to be highly correlated with clinical performance as a means of solving problems and performing clinical judgment [11]. Therefore, if simulation education that can promote clinical judgment ability and critical thinking ability are conducted organically, it will have a positive effect on training nursing students with clinical performance ability.

Nursing education using simulation education that is currently in progress is gradually evolving from simulations built on a topic or specific clinical situation to the development and evaluation of integrated simulations. In many countries where face-to-face education in schools and clinical sites is not permitted due to COVID-19, online simulation and telesimulation have been conducted, and studies are being conducted to evaluate their effectiveness [3, 12]. However, there is a limit to training towards clinical performance skills in simulation education conducted online. This study analyzed the effects of education through the before and after comparison of critical thinking disposition, clinical judgment, and simulation education effectiveness of 4th-grade nursing college students who received integrated simulation education. Through this, we intend to provide basic data for developing optimized integrated simulation education that maximizes the effectiveness of integrated simulation education, promotes clinical judgment and critical thinking, and helps to promote nurses with clinical performance capabilities.

The purpose of this study is to develop integrated simulation education and analyze the educational effect by comparing the critical thinking disposition and clinical judgment among 4th-grade nursing students who received integrated simulation education before and after the intervention and examining simulation effectiveness.

2. Materials and Methods

This study adopted a one-group pre- post-test design to understand critical thinking disposition, clinical judgment, and measure simulation effectiveness among 4th-grade nursing college students who received integrated simulation education.

Participants in this study are 4th-grade nursing students who applied for one credit in the "Simulation Practice" course in the regular 4th-grade course curriculum, completed the class, and agreed to participate in the research. The university's four-year ubiquitous quota is 140 students. For the Simulation Practice course, 126 people applied, all 126 people completed the mock practice course, but 48 people were eliminated due to invalid questionnaires. The final number of participants was 78. During the in situ simulation in the school, all students and faculty members always wore masks according to the quarantine authorities' guidelines. The number of students per class was kept to a minimum, and debriefing was held in a larger space than the existing debriefing room to ensure maximum social distancing.

2.1 Study measures

2.1.1 Integrated Vsim, Teledebriefing, and in situ Simulation (IVSTDSIM) application

This course was conducted at the level of in-school practice separately from clinical practice, and was operated as a simulation course. In particular, it is a characteristic of this study that the simulation education itself was conducted online and offline at the time when the clinical practice was conducted entirely online due to COVID-19. Therefore, according to the credits of this course, simulation education according to three subjects was conducted. This course was conducted in three subjects: adult nursing, child nursing, and maternal nursing, and was jointly operated by six faculty members consisting of four adult nursing professors, one child nursing professor, and one maternal nursing professor. The simulation practice course was operated by six professors each. Communication between medical staff was achieved using the Situation, Background, Assessment, Recommendation (SBAR) technique after a module theme selection meeting. The six modules developed by the professors were: treatment of patients with headache and low consciousness, nursing in case

of acute respiratory distress in children with bronchitis, management of patients with pain after surgery at the surgical site, emergency room acute management of patients with cholangitis, and management of normal delivery mothers. The principles of this module development were 1) to include various wards, 2) for the module to be suitable for the 4th-grade level, and 3) for the appropriateness of standardized modules. Therefore, the situation of this simulation practice (integrated simulation) targeted emergency room patients, hospitalization room patients, intensive care unit patients, pediatric intensive care unit patients, and delivery room patients. Classes were conducted in accordance with the standardized format developed by the in-school simulation committee based on the draft simulation practice standard set by the International Nursing Association for Clinical Simulation and Learning and the Korea Institute of Nursing Education and Evaluation. The module consisted of a scenario outline, scenario flow chart, evaluation, debriefing, student data, and distribution data.

Integrated simulation (IVSTDSIM) education consisted of a mixture of online and offline education; online education was conducted by virtual simulation (Vsim, Laerdal Korea) and offline simulation education was conducted at a simulation center in the nursing college. Through this, integrated simulation education was achieved by combining the diversity of simulation learning objectives with the synthesis of online and offline learning. The IVSTDSIM's educational flow is as follows: Initially, an orientation for online and offline simulation education was uploaded as pre-recorded data to the on-campus teaching and learning support center for students to learn and a pre-briefing was conducted before the in-school simulation was conducted. The second step was the virtual simulation(Vsim) program. After learning one adult nursing module for three hours and running the simulation, we outlined the debriefing tool for the students, debriefing for meaningful learning (DML), gather analysis summery(GAS) and teledebriefed for each group through a real-time zoom conference. In the third step, students came directly to the nursing college simulation center and received simulation training in which six modules were conducted for three days (in situ simulation). In terms of design, the composition of IVSTDSIM is an integrated design that incorporates virtual simulation, teledebriefing, in-school simulation, and various scenarios. The modules include scenarios of different settings and topics to solve problems related to adult nursing, maternal care, and childcare, and we used SimMan 3G, Simbaby, and noell mannequins with high fidelity depending on the module level. In terms of operation, each module was simulated for 4 h, and each module consisted of orientation and pre-briefing, simulation operation, and debriefing. The content of the IVSTDSIM education operation is shown in Figure 1.

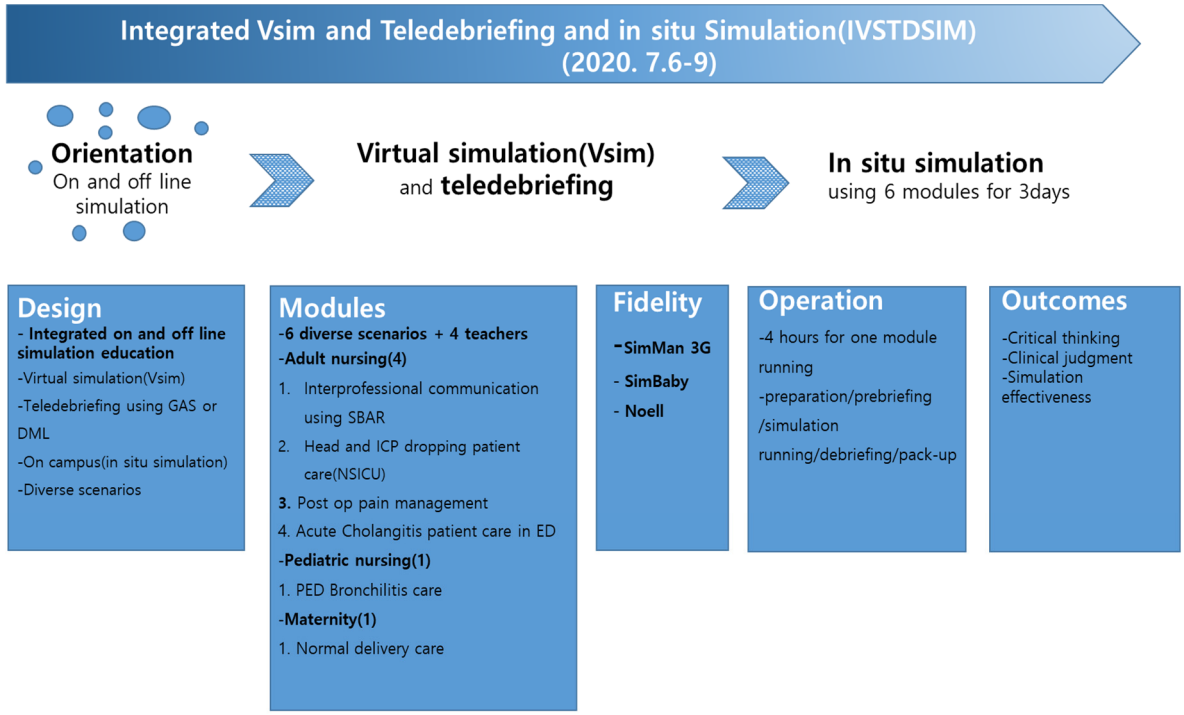


Figure 1. Integrated VS and teledebriefing and in situ simulation (IVSTDSIM)

2.1.2 Critical thinking disposition

Critical thinking disposition is a tool developed by Yoon [13] for nursing students and has been measured and validated by Shin et al. [14]. It consists of 27 questions in total focusing on prudence, intellectual passion and curiosity, confidence, intellectual fairness, system, sound skepticism, and objectivity which are measured on a 5-point Likert scale ranging from 1 point for "very rarely" to 5 for "very often." The higher the score, the higher the critical thinking tendency. The reliability of the tool was measured using Cronbach's α at .87 at the time of development, .842 in the validation study, and .911 in this study.

2.1.3 Lasater Clinical Judgement Rubric

Lasater Clinical Judgment Rubric (LCJR) is a tool developed to evaluate the clinical judgment ability in education through simulation [15] and was developed in the form of a rubric based on the clinical judgment model [16]. LCJR were translated and validated by Shim and Shin [17]. It consists of 4 sub-items of noticing, interpreting, responding and reflecting, and was scored on a 4-point Likert scale ranging from 1 for beginner to 4 for expert. The total score ranges from 11 to 44, the higher score indicating higher the clinical judgment ability. The reliability of the tool was measured using Cronbach's α at .80 in original tool, .884 at translation version, and .956 in this study.

2.1.4 Simulation Effectiveness Tool

The simulation effectiveness tool (SET) was developed to evaluate the effectiveness of simulation in nursing education [18]. The measurement tool, consisting of 13 items for two sub-factors of learning and confidence, was revised in 2015 to include 19 items for the four sub-factors of learning, confidence, pre-briefing, and debriefing [19]. It is composed of a 3-point Likert scale ranging from 1 for "do not agree" to 3 for "strongly agree." Reportedly, SET provides students with an opportunity to reflect on the simulation experience [19]. The reliability of the modified Simulation Effectiveness Tool (SET-M) was .936 for Cronbach's α at the time of development and .964 in this study.

2.2 Data collection period and method

The data collection period for this study was from July 6th to July 13th, 2020. The timetable for this course was 14.00 to 18.00 every Friday, and the university's practice consists of biweekly clinical and on-campus classes. A simulation class was held during theory lessons. However, due to the COVID-19 pandemic, in accordance with the national quarantine regulations, all curricula, including clinical practice were changed weekly (online to offline or vice versa) and it was not possible to proceed from March with the existing academic calendar. During the week before the summer holidays, students were divided into two classes, with each class lasting three days. On the first day of class, after explaining the purpose and method of the study, voluntary participation in the study, and protection of personal information to all study subjects, if they agreed to the study terms, they filled out the consent form and participated. For data collection, critical thinking disposition was investigated before the start of the practice and after the practice, and clinical judgment and simulation effectiveness were measured every after session of simulation.

2.3 Data analysis method

The collected data were analyzed using the SPSS WIN. The general characteristics of the study subjects were analyzed using a descriptive statistical method of percentage, mean, and standard deviation. For the comparative analysis of critical thinking disposition, clinical judgment, and simulation effectiveness before and after the practice, we conducted a paired t-test, and the reliability of each tool was analyzed using Cronbach's α.

3. Results

3.1 General Characteristics of Participants

The general characteristics of the subjects who participated in this study were evaluated by gender, average grade of credits achieved for three years up to the previous semester, and major satisfaction. The results are

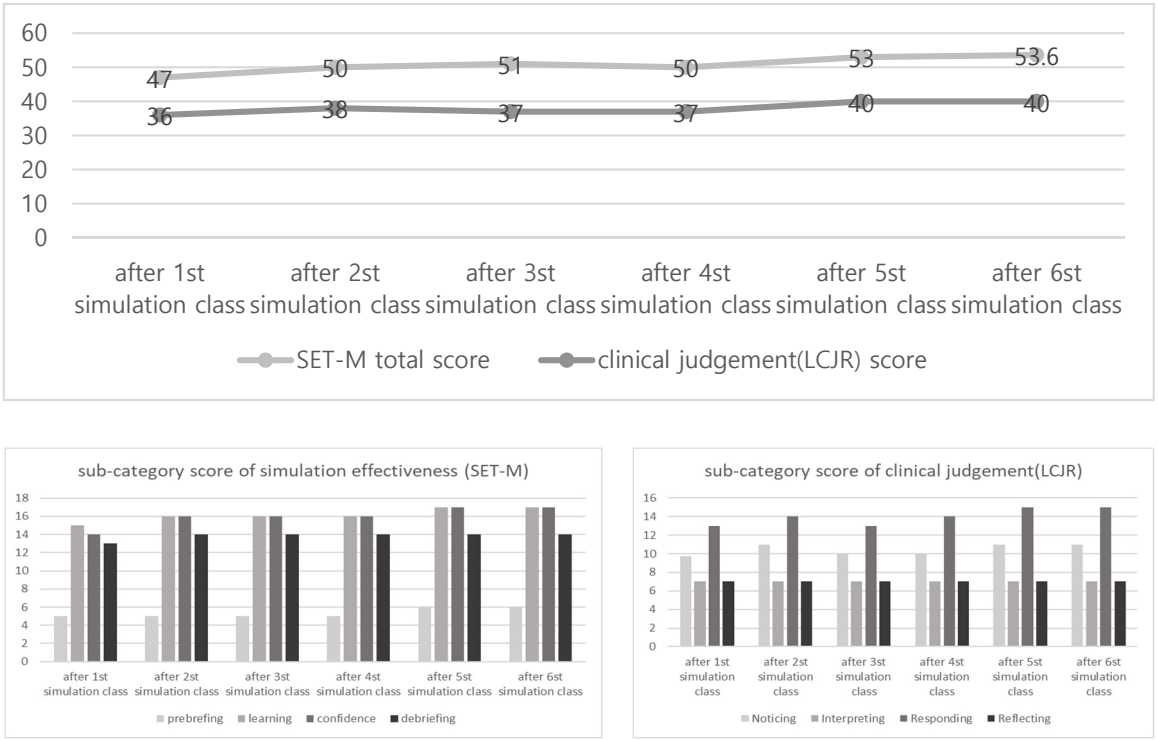
shown in Table 1. The average age of the subjects was 22.1 ± 1.14, and the proportion of female students was 89.7%. As for the degree of satisfaction with their major, “satisfaction” was the highest at 53.8%. The average grade points for the past three years were “High” and “Medium” respectively, both at 42.3%.

Table 1. General Characteristics of Participant (N=78)

Characteristics		N (%) or Mean (SD)
Age		22.1 (±1.14)
Gender	Male	8 (10.3)
	Female	70 (89.7)
Satisfaction with nursing major	Satisfied	42 (53.8)
	Neutral	33 (42.3)
	Dissatisfied	1 (1.3)
Mean grade level of last 3 years	High (A)	33 (42.3)
	Middle (B)	33 (42.3)
	Low (C)	10 (12.8)

3.2 Changes in clinical judgment and simulation effect according to the progress of simulation education

Figure 2 shows the change in clinical judgment and degree of simulation effect according to the progress of integrated simulation education. As simulation education progresses, learners’ pre-briefing, learning, confidence, and debriefing are increasing in all areas. Recognition and interpretation, a sub-area of clinical judgment ability, can be seen to increase as education progresses.



SET-M: Modified simulation effectiveness tool; LCJR: Lasater Clinical Judgment Rubric

Figure 2. Trend of SET and LCJR results according to the number of simulations.

3.3 The Effects of Integrated Simulation on Clinical Judgment, Critical Thinking Disposition and Simulation Effectiveness

In terms of the educational effectiveness of simulation education (integrated simulation education),

clinical judgment, simulation effectiveness, and critical thinking disposition were evaluated. The results are shown in Table 2.

The item clinical judgment showed a statistically significant difference (p <.001), with an average increase of 4.6 (7.91) in the post-test score compared to the previous one. It consists of four stages: cognition, interpretation, response, and reflection. When comparing the pre-post scores, the post scores in each area increased compared to the pre-scores. For response and cognition, the extent of the increase in the pre-test was greater than in the post-test, and all areas showed statistically significant differences. The post score for simulation effectiveness increased by an average of 6.1 (8.1) points compared to the previous score, showing a statistically significant difference *(*p<.001).

All areas of prebriefing (0.74±1.07), learning (2.1±2.77), confidence (2.3±3.25), and debriefing (0.94±1.97) showed statistically significant differences from pre- to post-test (p<.001) and increased. The critical thinking disposition increased by an average of 5.1 (±12.77) points in the post score compared to the prior score, showing a statistically significant difference (p=.001). If you look at the detailed areas, confidence (1.0±2.89, p=.003), curiosity (1.5±3.51, p<.001), objectivity (0.6±1.61, p<.001), skepticism (0.7±2.33, p=.006), and systematicity (0.9±2.01, p<.001), the post score increased significantly compared to the pre-test score. For prudence (-0.1±3.1, p=.773), the post-test score decreased, but it was not statistically significant. The score for intellectual fairness (0.29±2.22, p=.246) decreased post-test, but the difference was also not statistically significant.

Table 2. The Effects of Integrated Simulation on Clinical Judgment, Critical Thinking Disposition, and Simulation Effectiveness

Variables		Pre- test Mean±SD	Post-test Mean (SD)	Post-test – pre-test	t	p
Clinical judgement	Noticing	9.7 (1.84)	11.1 (1.51)	1.3 (2.41)	5.11	<.001
	Interpreting	6.5 (1.27)	7.4 (1.03)	0.7 (1.57)	4.32	<.001
	Responding	12.9 (2.54)	14.8 (1.74)	1.9 (2.9)	5.67	<.001
	Reflecting	6.9 (1.13)	7.5 (0.94)	0.58 (1.50)	3.45	.001
	Sum	36.3 (6.34)	40.9 (4.96)	4.6 (7.91)	5.20	<.001
Simulation effectiveness	Prebriefing	4.84 (1.06)	5.5 (0.76)	0.74 (1.07)	6.11	<.001
	Learning	14.7 (2.85)	16.8 (2.10)	2.1 (2.77)	6.76	<.001
	Confidence	14.4 (3.22)	16.7 (2.20)	2.3 (3.25)	6.37	<.001
	Debriefing	13.3 (2.00)	14.3 (1.58)	0.94 (1.97)	4.24	<.001
	Sum	47.4 (8.20)	53.6 (6.35)	6.1 (8.1)	6.71	<.001
Critical thinking disposition	Confidence	15.0 (2.34)	16.0 (2.74)	1.0 (2.89)	3.04	.003
	Eagerness	19.1 (3.03)	20.6 (3.08)	1.5 (3.51)	3.83	<.001
	Fairness	17.0 (1.90)	17.35 (1.93)	0.2 (2.22)	1.16	.246
	Objectivity	12.6 (1.40)	13.3 (1.42)	0.6 (1.61)	3.78	<.001
	Prudence	14.9 (2.54)	14.8 (2.51)	-0.1 (3.12)	-0.29	.773
	Skepticism	15.3 (1.96)	16.1 (2.31)	0.7 (2.33)	2.81	.006
	Systematicity	11.2 (1.65)	12.2 (1.98)	0.9 (2.01)	4.21	<.001
	Sum	105.6 (11.07)	110.7 (11.72)	5.1(12.77)	3.53	.001

4. Discussion

This study was conducted to develop an on/offline integrated simulation program and to evaluate whether it improved clinical judgment and critical thinking disposition and whether the simulation was effective. The goal of nursing practice education is to cultivate nurses' clinical performance ability to perform specialized nursing work in clinical practice. The learning goal of nursing practical education is to achieve the ultimate goal of improving clinical performance when the cognitive, emotional, and psychodynamic learning objectives proposed in Bloom's learning objective classification system [20] are integrated. Even in situations where clinical practice education cannot be performed in the clinical field, it is necessary to construct a practical, appropriate program to achieve clinical performance capability so nursing students can become competent nurses. Education after COVID-19, which brought about changes in the accessibility of clinical sites and the face-to-face classroom environment, is undergoing a rapid paradigm shift, and nursing education also requires changes in teaching methods and strategies according to this trajectory [21].

As schools were closed not only in local universities but also overseas, lectures and hands-on education have been conducted using online programs such as Skype, Moodle, Google Classroom, and Zoom in places

such as Australia, the United States, and Europe [22,23]. As face-to-face education has been changed to be fully online or partially online-offline, training methods for practical clinical performance have become a central issue.

In this study, an integrated simulation was developed so that online and offline methods were linked and nurses could acquire related knowledge and practice clinical judgment and critical thinking through the related online simulation situation, and experience the actual performance through offline simulation. To do this, the teaching-learning strategy is to "think like a nurse," or, to develop clinical judgment. It was decided that pedagogy should be applied to practice communication methods, virtual simulations to connect with clinical skills, and intensive training period planning and telebriefing methods to minimize face-to-face communication. Mahmoud et al. [23] confirm the work of Esposito and Sullivan [24], proposing that virtual simulation consists of three types of simulation: simulation using haptic equipment, computer-based simulation (CBS), and simulation using a head-mounted display (HMD) such as Oculus. Among them, the most commonly used forms are CBS and HMD [25]. Simulation using haptic equipment has the best effects in terms of realism, immersion, skill acquisition, and usability; therefore, to confirm this, it is necessary to overcome technical limitations and make efforts to develop more content [25].

Simulation education is known to be an effective way to improve clinical judgment. Tanner [16] stated that the clinical judgment model allows data to be collected in the clinical judgment process, understanding the needs of subjects, analyzing and prioritizing the data, and, consequently, planning and applying the most appropriate action. It has been suggested that this process will affect nursing performance and learning in the future. Through the integrated simulation program, participating students practiced this course, and the scores increased in all areas when compared to the previous scores; so, this program can be said to have an impact on nurses' clinical judgment abilities. It also supports the fact that simulation education can improve clinical judgment, as in previous studies [26], in a variety of clinical situations.

Educational learning methods based on constructivist learning theory are known to improve problem-solving skills and the metacognition and critical thinking that influence them [23]. Simulation education is a representative teaching and learning method based on the constructivist learning theory. Increasing the degree of critical thinking tendencies can have a positive impact on improving problem-solving skills and clinical outcomes. In this study, the statistically significant increase in the post-test score compared to the pre-test score of the critical thinking disposition seems to have a positive effect on the critical thinking disposition of the integrated simulation program of this study. In particular, scores increased significantly in the areas of trust, curiosity, objectivity, skepticism, and organizationality between sub-areas.

A possible reason for this is that repetitive learning of the decision-making process by integrating meaningful data and collecting and analyzing this data is considered important for critical thinking and clinical judgment. What you learn in the simulation process is the process of analyzing information, interpreting it, and making decisions in a short period of time, which does not seem to have a significant impact on the areas of prudence or intellectual fairness. A statistically significant increase in critical thinking propensity was determined the findings of a study evaluating the impact of mixed simulations on the protection of children with asthma [27], and the results of Lim & Yeom's previous studies evaluating the effectiveness of an integrated program of virtual reality simulation and clinical practice [11]. However, there are prior studies [28,29] that do not significantly change the propensity of critical thinking, so a careful approach is required to generalize the results.

For simulation education to improve problem-solving ability and clinical performance ability through clinical judgment ability and critical thinking ability, sufficient participation in learning should be achieved [30]. In that respect, it is important to evaluate whether the learner has sufficiently participated in the learning process and whether they have gained confidence through learning. As the integrated simulation program progresses in all areas of the simulation effect, the increase in the effect can be seen as supporting evidence that sufficient participation in learning has been achieved.

This study is significant because it practices the clinical judgment and problem-solving process through virtual reality simulation and telebriefing processes. Furthermore, it does this repeatedly in an environment similar to the actual clinical situation through an intensive course using high-fidelity simulators or hybrid simulations. Through this, the learner is fully engaged in learning and can achieve positive results. This is an educational method that reflects the Korean context, and interventions have been attempted in ways other than remote as well as remote simulation in several countries, including the United States, where the COVID-19 epidemic is active. This study was conducted in a single group and is, thus, difficult to generalize. A study

integrating virtual reality simulation education and clinical practice [11] or one combining virtual reality simulation education for a situation and simulation education using high-fidelity mannequins should be conducted in the future [27] According to the results reported in previous study [27], it is thought that education conducted by integrating VR simulation is more effective in enhancing the success of learning than a single method of simulation.

Based on the results of this study, the following suggestions are made. First, since this study was conducted at one university in one region, it is necessary to expand and repeat this research. Second, as a study of a single group, its generalizability is limited, so an additional study is needed to verify the effectiveness of simulation education by designing an experimental group and a control group. Third, research is needed to develop optimized integrated simulation education by conducting studies that include various teaching and learning methods and various educational effect variables to prove simulation's effects.

5. Conclusions

This study was conducted as a single-group pre-post-test study to evaluate nurses' clinical judgment and critical thinking disposition by applying the virtual reality simulation and integrated simulation education using high-fidelity simulators. The results of this study showed that integrated simulation education had a significant effect on nurses' clinical judgment and critical thinking disposition. Thus, this type of integrated simulation could help to establish the direction for nursing education during pandemic and after. Further, overall, the integrated simulation learning program was effective in teaching nursing college students.

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