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ORIGINAL ARTICLE

Effects of high-fidelity patient simulation led clinical reasoning course: Focused on nursing core competencies, problem solving, and academic self-efficacy

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Abstract

Aim: To examine the effects of high-fidelity patient simulation (HFPS) led clinical reasoning course among undergraduate nursing students.

Methods: A quasi-experimental study of non-equivalent control group pretest–post test design was applied. A total of 49 senior nursing students participated in this study. The experimental group consisted of the students who took the "clinical reasoning" course ($n = 23$) while the control group consisted of students who did not ($n = 26$). Self-administered scales including the nursing core competencies, problem solving, academic self-efficacy, and Kolb learning style inventory were analyzed quantitatively using SPSS version 20.0. Data analysis was conducted using one-way ANCOVA due to a significant difference in nursing core competencies between the experimental group and control group.

Results: There was a significant improvement in nursing core competencies in the experimental group ($F = 7.747$, $P = 0.008$). The scores of problem solving and academic self-efficacy were higher in the experimental group after the HFPS led clinical reasoning course without statistical difference.

Conclusion: There is a need for the development of effective instructional methods to improve learning outcomes in nursing education. Future research is needed related to simulation education as well as management strategies so that learning outcomes can be achieved within different students' learning style.

Key words: clinical reasoning, high-fidelity patient simulation, learning styles, nursing education.

INTRODUCTION

Healthcare environments have become more complex, diverse, and dramatically changed. Nurses require more advanced clinical decision-making and problem-solving skills for patient care. To ensure patient safety, an effective teaching methodology is in need to foster nursing students' competency.

One of the important goals of nursing education is to produce nurses who are competent in many areas of health care. In order to achieve a certain level of competency, nurse educators need to provide learning opportunities for students covering multiple patients' cases such as unpredictable clinical situations threatening patient safety (Decker, Sportsman, Puetz, & Billings, 2008). However, the contemporary clinical setting has limitations in the learning process due to changes in the healthcare environment such as protecting patients' rights or decreased duration in the length of hospitalized period. The use of high-fidelity patient simulation (HFPS) was begun in the 1990s in the healthcare area. HFPS promotes student competency by giving an opportunity to care in diverse clinical situations in a simulated environment (Blum, Borglund, & Parcells, 2010; Ironside, Jeffries, & Martin, 2009). With this advantage, the HFPS is rapidly increasing in nursing education world widely despite the initial costs related

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to technology investment and manpower training (Garrett, MacPhee, & Jackson, 2010). Most nursing education institutions are developing and applying HFPS curriculums to make up for the nursing education. Thus, this study examined the effectiveness of HFPS curriculums on nursing students' nursing core competencies, problem solving, and academic self-efficacy. Additionally, the influence of students' learning styles on selecting the learning method of HFPS was analyzed among undergraduate nursing students.

BACKGROUND

Simulation is defined as a direct, experimental, and active learning method that can practice clinical decision-making by re-enacting actual clinical situations in a safe environment (Fay-Hillier, Regan, & Gallagher Gordon, 2012). Specifically, in nursing education, the HFPS curriculum is an instructional method in which students can use cognitive, knowledge, and affection in the nursing process applying critical thinking, decision-making, and delegation. The HFPS education also helps to promote students' problem-solving abilities (Nehring & Lashley, 2004).

In particular, realistic reactions are possible in HFPS (e.g. physiological reactions), it arouses the learner's interest, and provides the opportunity to experience various things such as playing a new role, learning from experience, taking on a challenge, and enhancing nursing skills by solving problems in a self-initiated manner (Blum *et al*., 2010; Bultas, 2011). Larew, Lessans, Spunt, Foster, and Covington (2006) developed a clinical simulation protocol based on Benner's conceptual framework about nurses' level of clinical competency. According to this protocol, the HFPS helps to recognize patient problem for students, acquire nursing performance skill, and practice communication skills. Through this protocol, students participate in a cooperative problem-solving process with team members. The result of simulation education showed that it enhanced the confidence of nursing students in practice and led them to participate more actively in learning (Decker *et al*., 2008; Liaw *et al*., 2010).

In addition, the HFPS helps to promote students' clinical judgment (Tanner, 2006). Using simulation learning, students can link theory to clinical practice (McCaughey & Traynor, 2010), and develop clinical judgment applying integrated thinking skills (Hur & Roh, 2013). Several studies have been conducted in various situations, namely, pediatric (Kim, Nam, & Kim, 2014; Shin & Kim, 2014), maternity (Chung, Kim, & Park, 2011; H. Y. Kim, Ko, & Lee, 2012), and older adult simulation (Lasater, Johnson, Ravert, & Rink, 2014).

However, learners have different levels of efficacy and satisfaction in the learning elements of the simulation process, and these factors ultimately influence academic achievement (Issenberg, McGaghie, Petrusa, Lee Gordon, & Scalese, 2005). The outlook on ways to interact with the environment vary according to one's learning style, and it influences methods to acquire new knowledge or technology (An, 2007; Stradley *et al*., 2002). Therefore, learning outcomes can be maximized by determining the learner's learning style in advance. Thus, this study verified whether there is a difference in learning styles between students who selected the HFPS learning course. Mainly, this study analyzed the effects of the HFPS curriculum on nursing core competencies, problem solving, and academic self-efficacy of undergraduate nursing students.

Hypotheses

The following specific hypotheses were used in this study:

1 The experimental group that received HFPS education would report a higher score in nursing core competencies than the control group.
2 The experimental group that received HFPS education would report a higher score in problem solving than the control group.
3 The experimental group that received HFPS education would report a higher score in academic self-efficacy than the control group.

METHODS

Research design and sample

This study is a quasi-experimental study of non-equivalent control group pre-post design. The research subjects were selected by convenience sampling, targeting the senior students in a nursing college in Seoul who take elective courses as part of the integrated curriculum. The experimental group consists of the students who took the "clinical reasoning" course ($n = 23$) while the control group consists of students who did not ($n = 26$). The G*power 3.1.2 program was used for post-hoc test on the adequacy of sample size when the level of significance of the sample size is $\alpha = 0.05$, the effect size is $d = 0.50$, and the number of samples is 49 by the formula of Cohen and Rabin (Cohen & Rabin, 1998) showing the power of 94.8%.

The research was conducted after receiving the approval of the Bioethics Committee of University College of Nursing (institutional review board no. 2012-0001). First, the subjects were notified of the research purpose and method, and they signed the consent form of research participation. The subjects were assured that anonymity and confidentiality would be guaranteed, and that they could withdraw anytime, even in the middle of the study. All subjects were given a small incentive to thank them for their participation in this study.

HFPS education program

The clinical reasoning course is an independent 2 credit subject rather than a part of clinical training, which aims to foster the ability to integrate the knowledge, skills, and attitude in the nursing process. In this study, it was carried out once a week for 2 h each for a total of 16 weeks (total, 32 h). The curriculum was organized and managed based on the simulation education contents for undergraduate nursing students by Jeffries (Jeffries, 2005). Further information can be obtained from previous reports (Lee & Choi, 2011; Lee, Kim, Yeo, Cho, & Kim, 2009). The scenarios included situations that are commonly experienced on the actual clinical site (e.g. postoperative care) as well as those that are not (e.g. side-effects of morphine). The scenarios are developed for the learner to take independent measures in given situations within a limited time while utilizing a series of steps such as identification and assessment of the subject's problem, nursing diagnosis, nursing intervention planning and prioritization, and nursing intervention fulfillment and evaluation. For example, when developing a scenario related to the side-effects of morphine overdose, the scenario must present a complicated clinical situation realistically by not only focusing on the patient's state but also examining how much attention students pay to the patient's safety, such as assessment of fall risk when caring for elderly patients without railings on their beds. The learning objectives were set considering the courses previously taken by the learner when developing a scenario by including specific and realistic clinical information.

For the scenario development, the instructor received training related to simulation education in nursing science. In order to achieve clinical reliability, the instructor had several meetings with clinical staff. After the scenario development, its actual applicability to undergraduates was tested through the rehearsal process with graduate students; after which, the actual application to the students was implemented. As the senior students of a nursing college mostly had clinical training at a hospital ward, the education goals emphasized the contents expected from novice nurses at a ward (Bowen, 2006).

The scenario implementation was conducted so that the student could independently assess the current state of patients and the doctor's prescriptions in a virtual clinical situation. Data collection and verification of the problem consequently followed. The students were randomly organized into six groups, each consisting of three to four people. Each group implemented the scenarios in consecutive order within 15–20 min each, and while one group implemented a scenario, the other groups observed their colleagues on a real-time video. The instructor observed this process in the control room and interacted with the students by playing the role of the patient or doctor. Immediately after the scenario implementation of all groups was completed, the learners and instructor moved to the seminar room to describe and analyze the nursing activities performed by students in a 50 min debriefing session.

The control group chose to take the "critical patient nursing" course, which covered contents related to critical care for each physical system. The course required 2 h per session for a total of 16 weeks (total, 32 h), and was carried out with a traditional lecture method.

Instruments

Demographics instrument

The demographic characteristics consist of questions related to age, sex, reason for applying for nursing, career planning after graduation, and learning styles, which were all included in the preliminary survey.

Learning style

The students' learning styles were measured by Kolb Learning Style Inventory. (Kolb, 2007). This tool consists of 12 self-descriptive questions that evaluate the learning styles and coping ways in different learning situation. Twelve incomplete sentences are presented, along with four examples for each sentence. The four examples describe the four stages of concrete experience (CE), reflective observation (RO), abstract conceptualization (AC), and active experimentation (AE). The respondents are expected to rate the four given examples on a 4 point scale, with 4 points indicating the example that best describes the respondent and 1 point indicating the example that least describes the respondent. The learning style can be determined using two types of scores among the sums of each stage: the score obtained

by subtracting CE from AC, and the score obtained by subtracting RO from AE. The learning style is categorized into four types: "diverger", "assimilator", "converger", and "accommodator". According to Kolb (Kolb, 1985), divergers have superior learning ability in observing and feeling due to their preference for concrete experience and reflective observation, and they see a specific situation from various angles and deal with it discreetly. Assimilators test theories and build conceptual models via analyzing data. Convergers are good at the practical use of knowledge and theories, skilled at creating new ways of thinking and business development, and have outstanding decision-making or problem-solving skills. Lastly, accommodators show interest in participating in a new experience when doing something, as they prefer concrete experience and active experimentation.

In the tool development, the reliability was Cronbach's $\alpha = 0.88$–0.89; in this study, the Cronbach's α was 0.85–0.64 ($\alpha = 0.85$ in CE, $\alpha = 0.64$ in RO, $\alpha = 0.85$ in AC, and $\alpha = 0.75$ in AE).

Nursing core competencies

The nursing core competencies measurement tool developed by Lee (Lee, 2011) was used to measure the nursing core competencies of the students. This tool is categorized into five subcategories such as critical thinking and evaluation (14 questions), general clinical practice capability (13 questions), special clinical practice capability (nine questions), human understanding and communication (21 questions), and professional attitude (13 questions); all of which add up to a total of 70 questions. The 5 point Likert scale ranged from "cannot perform at all" (1 point) to "can perform with extreme confidence" (5 points), with higher scores indicating higher nursing core competencies. In the survey of 528 new nurses among the prospective graduates of the bachelor's program of nursing, the internal consistency reliability of the tool was Cronbach's $\alpha = 0.94$; in this study, the Cronbach's α was 0.98.

Problem solving

Problem solving is the ability of an individual to clarify a problem, develop alternatives through causal analysis of problem solving, and systematically manage implementation plans up to evaluation of performance outcomes (Lee, Chang, Lee, & Park, 2003). This study used the problem-solving skills tool among the life competence measurement tools developed by Lee *et al.* (2003) and this tool is classified into five subcategories of problem clarification (5 questions), causal analysis (10 questions), alternative development (10 questions), planning/implementation (10 questions), and performance assessment (10 questions), which add up to a total of 45 questions. The 5 point Likert scale ranged from "extremely rare" (1 point) to "extremely often" (5 points), with higher scores indicating higher problem-solving skills. In the original tool, the reliability was Cronbach's $\alpha = 0.94$; in this study, the Cronbach's α was 0.90.

Academic self-efficacy

Academic self-efficacy refers to the learner's own ability to organize and implement the activities necessary in performing an academic task related to the learning situation (Kim & Park, 2001). This study used the academic self-efficacy tool developed by Kim and Park (2001). This tool is classified into three subcategories of task difficulty (10 questions), self-regulated efficacy (10 questions), and confidence (8 questions), adding up to a total of 28 questions. The 6 point Likert scale ranged from "strongly disagree" (1 point) to "strongly agree" (6 points), with higher scores indicating higher academic self-efficacy. Negative questions (2, 3, 6, 7, 21–28) were reverse-scored for the analysis. In the tool development, the reliability was Cronbach's $\alpha = 0.82$; in this study, the Cronbach's α was 0.89.

Data collection procedures

This study collected data using the form of self-report in the order of pretest, program implementation, and posttest. The pretest investigated the nursing core competencies, problem solving, academic self-efficacy, learning style, and general characteristics of the experimental group and control group by conducting a survey before the program and on the first day of the "clinical reasoning" course. The clinical reasoning course was carried out for a total of 16 weeks, and the main variables of the experimental group and control group were investigated through a survey after course completion.

Data analyses

The data collected in this study were analyzed using the SPSS version 20.0 (IBM, Armonk, NY, USA). The general characteristics of the subjects were obtained using frequency and percentage. Difference between the experimental group and control group was verified by the Mann–Whitney *U*-test and Fisher's exact test.

Hypothesis testing was conducted using ANCOVA due to a significant difference in nursing core competencies between the experimental group and control group.

RESULTS

Sample characteristics

Table 1 presents sample characteristics. A total of 49 subjects participated in the study. Both the experimental ($n = 23$) and control groups ($n = 26$) were homogenous without significant difference in terms of age, motivation for applying for nursing, career planning after graduation, and learning style. Most of the experimental group were convergers ($n = 9$, 42.9%), while the control group were mostly divergers ($n = 7$, 29.2%) and accommodators ($n = 7$, 29.2%); however, there was no statistically significant difference in learning style between the experimental group and control group ($P = 0.401$).

The result of the homogeneity test on the nursing core competencies, problem solving, and academic self-efficacy of the experimental group and control group before implementing the program showed that there was a statistically significant difference in the pretest scores of nursing core competencies between the two groups ($P = 0.003$), while there was no statistically significant difference in problem solving and academic self-efficacy between the two groups (Table 2).

Research hypothesis

As the result of preliminary homogeneity test showed significant difference in nursing core competencies between the experimental group and control group, the hypothesis testing was performed by ANCOVA (Table 3).

The result of verifying hypothesis 1 showed that the experimental group significantly scored higher on nursing core competencies (256.47 ± 32.33; $F = 7.747$, $P = 0.008$) compared with the control group, thereby supporting hypothesis 1.

The result of verifying hypothesis 2 showed that the experimental group (165.19 ± 15.24) showed a greater increase in problem-solving score compared with the control group (160.35 ± 15.94) after the clinical reasoning course but there was no significant difference between the two groups statistically ($F = 1.221$, $P = 0.275$); thus, hypothesis 2 was rejected.

The result of verifying hypothesis 3 showed that the experimental group (114.83 ± 13.9) increased in

Table 1 Homogeneity of general characteristics between two groups ($n = 49$)

Characteristics	Experimental group ($n = 23$) N (%)	Control group ($n = 26$) N (%)	Total ($n = 49$) N (%)	χ^2	P
Age (years)					
21	3 (13.0)	7 (26.9)	10 (20.4)	2.425	0.297
22	19 (82.6)	19 (3.1)	38 (77.6)		
≥23	1 (4.3)	0 (0.0)	1 (2.0)		
Academic motivation†					
High employment rates	3 (13.6)	6 (23.1)	9 (18.8)	4.189	0.547
Aptitude for nursing	4 (18.2)	4 (15.4)	8 (16.7)		
Correspond to score	3 (13.6)	7 (26.9)	10 (20.8)		
Recommendation of family and surrounding	7 (31.8)	7 (26.9)	14 (29.4)		
Nurse's good image	3 (13.6)	2 (7.7)	5 (10.4)		
Miscellaneous	2 (9.1)	0 (0.0)	2 (4.2)		
Plan after graduation†					
Hospital nurse	19 (86.4)	20 (76.9)	39 (81.2)	3.530	0.335
Community nurse	3 (13.6)	2 (7.7)	5 (10.4)		
Industrial nurse	0 (0.0)	1 (2.1)	1 (2.1)		
etc	0 (0.0)	3 (11.5)	3 (6.2)		
Learning style†					
Diverger	3 (14.3)	7 (29.2)	10 (22.2)	2.896	0.436
Assimilator	5 (23.8)	4 (16.7)	9 (20.0)		
Converger	9 (42.9)	6 (25.0)	15 (33.3)		
Accommodator	4 (19.0)	7 (29.2)	11 (24.4)		
Total	23 (100.0)	26 (100.0)	49 (100.0)		

†Fisher's exact test.

Table 2 Homogeneity of variables between two groups ($n = 49$)

Variables	Experimental group ($n = 23$) Mean ± SD		Control group ($n = 26$) Mean ± SD		Mann–Whitney *U*-test	*P*
Nursing core competencies	196.97	24.569	228.97	41.411	150.5	0.003
Problem solving	157.67	16.229	156.7	15.964	294	0.920
Academic self efficacy	109.91	16.968	109	16.524	296	0.952

SD, standard deviation.

Table 3 Comparison of variables between two groups ($n = 49$)

Variable	Group	Pretest Mean ± SD	Posttest Mean ± SD	$F^{\dagger}$	*P*
Nursing core competencies (total)	Exp ($n = 23$)	196.97 ± 24.57	256.47 ± 32.33	7.747	0.008
	Con ($n = 26$)	228.97 ± 41.41	247.26 ± 23.17		
Understanding humans and communication	Exp ($n = 23$)	64.31 ± 9.19	79.55 ± 10.08	4.410	0.041
	Con ($n = 26$)	70.04 ± 14.6	76.52 ± 7.37		
Professional attitudes	Exp ($n = 23$)	40.66 ± 7.92	49.22 ± 7.53	5.362	0.025
	Con ($n = 26$)	44.2 ± 8.83	46.88 ± 6.11		
Critical thinking and evaluations	Exp ($n = 23$)	36 ± 5.38	50.07 ± 5.94	1.762	0.191
	Con ($n = 26$)	46.31 ± 8.02	49.65 ± 4.87		
General nursing competency	Exp ($n = 23$)	34.65 ± 4.72	46.43 ± 6.42	3.537	0.066
	Con ($n = 26$)	42.08 ± 7.41	45.54 ± 5.4		
Special nursing competency	Exp ($n = 23$)	21.34 ± 3.55	31.19 ± 4.67	12.036	0.001
	Con ($n = 26$)	26.34 ± 6.44	28.65 ± 5.1		
Problem solving	Exp ($n = 23$)	157.67 ± 16.23	165.19 ± 15.24	1.221	0.275
	Con ($n = 26$)	156.7 ± 15.96	160.35 ± 15.94		
Academic self-efficacy	Exp ($n = 23$)	109.91 ± 16.97	114.83 ± 13.9	1.976	0.167
	Con ($n = 26$)	109 ± 16.52	110.19 ± 13.15		

$^{\dagger}F$-score is ANCOVA with pretest scores as covariates. Con, control group; Exp, experimental group; SD, standard deviation.

academic self-efficacy score more greatly than the control group (110.19 ± 13.15) but there was no significant difference between the two groups statistically ($F = 1.976$, $P = 0.167$); thus, hypothesis 3 was rejected.

DISCUSSION

This study was conducted to examine the effects of HFPS education on nursing core competencies, problem solving, and academic self-efficacy of nursing students. With the increasing number of complex chronic patients, nurses' clinical reasoning is critical, therefore, the results of this study are remarkable.

Interestingly, the learning styles between the experimental and control groups differed. Students with a converging style were prominent in the experimental group (42.9%) compared with the control group (25%). In An and Yoo (2008)'s study about the learning style of nursing students, learners with a converging style were found to be good at applying knowledge and theory to make a decision or solve a problem. From this perspective, the students who took the clinical reasoning course were convergers in this study, who might prefer the course. According to previous research, learning styles impact on knowledge gain, critical thinking, academic achievement, and student satisfaction (An, 2007; Gurpinar, Alimoglu, Mamakli, & Aktekin, 2010; Shinnick & Woo, 2015). Thus, it is important to consider learning style in nursing education to increase the effect of programs and students' learning.

The HFPS was effective in enhancing nursing core competencies including human understanding and communication, professional attitude, and special clinical practice capability ($P = 0.008$). This conclusion is similar to Shin and Kim's (2014) study of pediatric simulation practicum of the target of 95 undergraduate students. According to the study, HFPS influences and enhances critical thinking ability. Overall, these findings

indicate that undergraduate nursing students experience improved levels of performance, insights and clinical judgment, and clinical reasoning skills through a systemized debriefing method (Dreifuerst, 2012; Hur & Roh, 2013; Simmons, Lanuza, Fonteyn, Hicks, & Holm, 2003).

Communication is also an essential competency for patient-centered nursing and effective multidisciplinary teamwork, and must be reinforced in nursing education. Compared with previous research, this conclusion is remarkable. Kim *et al.*'s (2012) quasi-experimental study presented that HFPS education on maternity nursing practicum was significantly effective in promoting communication skills of the experimental group. A previous study demonstrated that simulation education showed the positive impacts of inter-professional communication skills (Liaw, Zhou, Lau, Siau, & Chan, 2014). However, there is insufficient evidence to validate the effect of communication skills. Further studies are in need to prove the affirmative effect of HFPS on communication skill development.

The mean score of problem solving of experimental group was increased from 157.67 to 165.19 without statistically significant difference ($P = 0.920$). Searching for previous studies, there were inconsistent conclusions. Despite self-directedness problem solving being an important factor, nursing faculties may not consider that when they give a simulation situation to undergraduate students (Kim *et al.*, 2012). Thus, further studies should be conducted on HFPS curriculum to develop students' problem-solving skills.

Academic self-efficacy was increased after HFPS without statistically significant difference in this study. Academic self-efficacy is thought to be associated with several variables (Blum *et al.*, 2010; Kardong-Edgren, Starkweather, & Ward, 2008). Blum and colleagues reported that students of a higher grade achieved greater self-efficacy than students of a lower grade after HFPS. Academic self-efficacy may be affected by individual level of nursing knowledge. HFPS will be more effective in those who have related nursing knowledge through prerequisite learning (Blum *et al.*, 2010; Bogossian *et al.*, 2014). A previous study showed improvement of self-efficacy suggesting repetitive performance with scenarios (Kardong-Edgren *et al.*, 2008). Improvement of academic self-efficacy within a short period of the course can be difficult to be achieved. Considering the fact that academic self-efficacy is closely related to the internal motivations, continuous learning through HFPS should be planned in self-directed learning environments (Kardong-Edgren *et al.*, 2008).

Limitation

There are several limitations in this study. First, there was a risk of selection bias. The students who selected the clinical reasoning course in the experimental group had higher expectations and motivations for HFPS education than the control group. Heterogeneity between two groups was found in nursing core competency. Although the difference was controlled applying the ANCOVA method, it could not justify the influence of exogenous variables. Experimental research by random allocation is required in the future studies to decrease risk of bias and secure homogeneity among subjects.

Second, all variables in this study were measured with self-report tools, which possibly threatens internal validity. Additionally, nursing core competency especially needs to be evaluated by an objective method to identify the effect of an education program.

Finally, the results were drawn by a single program at a single site, which may lead to single-operation bias. Repeated research should be conducted to generalize the effect of HFPS program.

CONCLUSION

As a result of this study, the "clinical reasoning" course using HFPS was effective in improving the nursing core competencies of nursing students. However, it appeared not to influence problem solving and academic self-efficacy, which suggests that it is necessary to seek effective instructional methods by evaluating the effect of the simulation instructional method multilaterally. Moreover, there is a need for research that develops and evaluates goals of simulation education as well as management strategies so that effective learning outcomes can be achieved based on the learning styles of learners that are verified in advance.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

AUTHORS' CONTRIBUTIONS

JuHee and Yoonju designed the study and conducted the intervention. Yoonju collected the data. Senah and Juyeon performed the data analyses. All authors contributed to the writing of the manuscript. All authors approved the final version of the manuscript.

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