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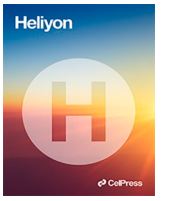

Research article

Comparing the effects of patient safety education using design thinking and case based learning on nursing students' competece and professional socialization: A quasi-experimental design

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ABSTRACT

Background: Patient safety issues should be constantly monitored and sensitively recognized. In nursing education, it is necessary to find effective teaching methods to increase students' competencies in patient safety.
Objectives: This study aimed to compare the effectiveness of a new method, design thinking (DT), and a traditional method, case-based learning (CBL), in patient safety education.
Design: This study used a quasi-experimental, pre-post control group design.
Settings: A 30-h training tutorial was developed for intervention groups, DT and CBL, while the control group received no treatment.
Participants: In this study were junior nursing students receiving baccalaureate nursing education with experiences of at least 480-h clinical practice. A total of 53 students (21 in the DT group, 19 in the CBL group, and 13 in the control group) were recruited.
Methods: Clinical reasoning competency, patient safety competency, and professional socialization were measured immediately after the end of the educational program using DT and CBL, 4 weeks later, and 8 weeks later. Effects of DT and CBL were analyzed using a generalized estimating equation.
Results: Both DT and CBL were effective in clinical reasoning competency ($\chi^2 = 15.432$, $p = 0.017$) and knowledge domain of patient safety competency ($\chi^2 = 42.824$, $p < 0.001$), showing no significant difference between the two. CBL was more effective in professional socialization than DT.
Conclusions: DT was as effective as CBL in clinical reasoning competency and knowledge domain of patient safety competency. In the healthcare field, where improving the patient experience is becoming increasingly important, DT is worth applying as an educational method to train nursing students who can take a creative and human-centered problem-solving approach. It is expected that educational curricula utilizing DT will be developed not only in the field of patient safety but also in various patient care areas.

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1. Introduction

Although most patient harm is avoidable, it remains challenging as one of the leading causes of death and disability today, and the economic costs of safety lapses are high [1]. This can place patients in a dangerous environment, delay treatment, extend financial resources, and cause financial losses. Therefore, patient safety is a concept that healthcare personnel must recognize and practice. In Korea, efforts are being made to ensure patient safety by enforcing the Patient Safety Act in 2016. Accordingly, the importance of patient safety education needs to be emphasized to improve patient safety in the undergraduate curriculum for training healthcare personnel.

Currently, the most common topic in Korean nursing schools is patient safety in clinical fields such as hand hygiene, infection control, and safe medication [2]. As for the method of education, lectures account for the largest portion, followed by clinical practice and laboratory or simulation [2,3]. However, students are not well aware of how to apply theoretical concepts and principles of patient safety learned in lectures in actual nursing practice [4]. There are also areas of patient safety that they cannot acquire through lectures or clinical practice [2]. Patient safety issues can be revealed in various forms at all times in complex healthcare environments that change from time to time. Thus, they should be constantly monitored and sensitively recognized. Therefore, it is necessary to find an effective educational method to increase patient safety-related competencies by educating nursing students to ask creative and core questions.

A case-based learning (CBL) method is an effective educational method to develop problem-solving ability, critical thinking abilities, and skills in nursing education. It provides students with various clinical cases and allows them to solve problems [5,6]. Since patient safety is one of the practice areas that require a habit of identifying clinical problems and thinking thoughtfully [7], it is necessary for nursing students to develop the ability to identify actual or potential problems and to solve them according to the situation to care for patients as nurses in the clinical field later. CBL is a type of problem-based learning that uses cases to guide student to learn and inquire. CBL allows students to apply knowledge to cases and prepare for clinical practice [8]. Therefore, CBL is expected to be better than lectures or clinical practice in educating them on patient safety issues.

On the other hand, design thinking (DT) is a problem-solving method that has recently been applied to healthcare [9] and health professions education [10]. DT is a human-centered problem-solving mindset that can leads to innovation by understanding and empathizing customers with designer sensitivity [11]. It is a systematic innovation process that prioritizes deeply empathizing with desires, needs, and challenges of subjects to fully understand problems [12]. DT is also a methodology that enables skills through analytical thinking and creativity through intuitive thinking to dynamically interact and balance thinking [13]. When applied to teaching-learning methods, design thinking improves students' engagement and thinking processes and significantly overlaps with the tenets of constructivist learning theory [14]. In constructivist learning, students are encouraged to actively participate in their learning process. The teacher acts as a facilitator to help create meaningful connections between prior knowledge, new knowledge, and processes involved in learning [15]. In constructivist learning, knowledge is considered a dynamic and changing perspective on the world we live in, and that perspective can be expanded [15]. Based on this, design thinking is worth adopting as a method to enhance human care knowledge.

DT has already been applied for innovation in healthcare settings and evaluated to be useable, acceptable, and effective [16]. In a case of a DT applied to innovation of nursing homes, nurses who participated in the design thinking process with the help of a designer were able to provide higher quality care as their knowledge and skills were applied in a new way. DT can lead to a better understanding and new models for providing higher-quality services by engaging various stakeholders [17]. Hospitals that emphasize patient experience management are driving innovation in healthcare by hiring DT-savvy service design professionals in South Korea [18]. Thus, patient safety education using DT is expected to increase nursing students' competency to identify and solve safety issues as much as CBL.

So far, there have been few educational programs for nursing students using DT. In this study, patient safety education was conducted using DT and CBL for nursing students and their effects on competency-specifically clinical reasoning competency and patient safety competency were evaluated. Additionally, we determined if patient safety education using these two methods could ultimately improve nursing students' professional socialization, an inevitable outcome of nursing students' transition to professional nurses [19]. If effects of DT and CBL on nursing students' competencies were direct, the effect on professional socialization would be secondary. Through this study, we aimed to determine if DT could be utilized in nursing education like CBL.

1.1. Study aim

This study aimed to compare effects of DT and CBL in patient safety education. We hypothesized that DT and CBL could improve nursing students' competencies and that effects of DT would be comparable to those of CBL.

2. Methods

2.1. Design

This study used a quasi-experimental, pre-post control group design. The experimental group participated in the DT procedure. One control group participated in the CBL procedure and another control group took no intervention.

2.2. Participants

Participants in this study were 3rd year nursing students receiving baccalaureate nursing education accredited by the Korean Accreditation Board of Nursing Education from three nursing schools located in a metropolitan city in South Korea with experiences of at least 480-h clinical practice. Since the intervention in this study was about the process of solving problems related to patient safety, third-year students who had a prior understanding of patient safety through at least 480 h of clinical practice during one year were the most suitable subjects.

In previous studies, the effect sizes of educational intervention on skills and problem-solving ability were Cohen's d = 0.6 and 2.6 [20] and the effect sizes of the educational intervention on attitudes or ethics were Cohen's d = 0.4 and 0.7 [21,22]. In this study, attitudes and professional socialization were measured as well as knowledge and reasoning ability about patient safety. Therefore, the effect size was determined as medium (f = 0.25) based on four repeated measurements with interaction effect in three groups. With a power of 95 % by G*power program version 3.1.3, the number of subjected needed was calculated to be 45. Considering a dropout rate of 25 %, a total of 60 participants were needed for this study. We recruited participants from three nursing schools in a metropolitan city. A total of 53 students were recruited: 21 in the DT group, 19 in the CBL group, and 13 in the control group. There was no significant difference in age, gender, grade point average, or experience of receiving patient safety education among the three groups (Table 1).

2.3. Construction of DT tutorial

DT tutorial was developed based on the design thinking process [23]. It was constructed in five stages and a 30-h taking program. One expert working at a hospital care design center advised on this program. The tutorial outline is presented in Table 2.

The "Empathize" stage, it was planned to define stakeholders related to patients' safety, prepare questions for data collection, and collect data through site visits and interviews while discussing patients' safety issues experienced in clinical practices. The "Define" stage was planned to define patients' safety issues by creating a patient journey map that could visualize moments when patients encountered services in a hospital with drawings, photos, or diagrams and finding patterns in the patient journey map. Through this process, participants defined patients' safety issues by deriving the "How might we" questions. The "Ideation" stage was planned to perform brainstorming to generate various ideas for problem-solving. After selecting the best idea, the idea was refined and sketched. The "Prototyping" stage was planned to make a prototype to express ideas well. Prototypes could take various forms, such as models, diagrams, storyboards, and so on. The "Evaluation" stage was planned to set criteria by participants for evaluating the prototype and discuss how future clients would evaluate it.

2.4. Construction of CBL tutorial

We searched for patient safety accident reports in the Korea Patient Safety Reporting and Learning System (www.kops.or.kr) developed by Korea Institute for Healthcare Accreditation. According to these reports, patient safety issues related to blood transfusion, patient identification, operating room, falls, and medicine administration were reported most frequently. Five scenarios were made by reconstructing specific cases presented in these reports. Each scenario included common questions such as 'What is the fact and what is the problem in this scenario?', 'What hypotheses can be made about the patient's situation (problem)?', 'What more data are needed?', and 'What are learning issues?' Before solving problems, participants were asked to discuss their experiences of encountering the situation in scenarios during their clinical practices. It was a 30-h taking program just like the design thinking program. One nursing faculty who was an expert in education using CBL and simulation advised the CBL tutorial. The tutorial outline is presented in Table 3.

2.5. Data collection tools

2.5.1. Clinical reasoning competency

Nurses Clinical Reasoning Scale (NCRS) [24] was used to measure clinical reasoning competency. We used NCRS validated in the

Table 1
General characteristics of participants.

Variables		M±SD or N (%)			F/χ^2 (p)
		DT (n = 21)	CBL (n = 19)	Control (n = 13)	
Age		23.33 ± 1.07	22.74 ± 0.93	23.04 ± 0.96	2.014 (0.144)
Gender	Female	20 (95.2)	18 (94.7)	11 (84.6)	1.520 (0.468)
	Male	1 (4.8)	1 (5.3)	2 (15.4)	
Grade point average	≥4.0	4 (19.0)	4 (21.1)	5 (38.5)	7.869 (0.248)
	3.0–3.9	16 (76.2)	13 (68.4)	8 (53.9)	
	<3.0	1 (4.8)	2 (10.5)	1 (7.7)	
Patient's safety education experience	Yes	4 (19.0)	7 (36.8)	6 (46.2)	3.017 (0.221)
	No	17 (81.0)	12 (63.2)	7 (53.8)	

CBL = Case-Based Learning; DT = design thinking; M = mean; SD = standard deviation.

Table 2
Construction of design thinking tutorial.

Stage	Contents	Output	Time (hour)
Empathize	- Sharing experiences related to patient safety during clinical practices - Describing thoughts and feelings about the above experiences	Description	1
	- Grouping the discussion using memo notes	Grouping of memo notes	1
	- Answering the question "How can we reduce/prevent such patient safety issues?" - Deciding on one task to solve	Description	
	- Describing what the participants already know about the task and what they would like to know more about	Description	1
	- Listing the stakeholders involved in the task and visualizing their relationship using drawing or memo notes	Stakeholders map	1
	- Listing as many people, places, and situations as possible related to the task and choosing 3–5 of the most interesting ones	Description	1
	- Determining who to interview and who to ask questions or where and who we observe	Description	1
	- Fieldwork; collecting data	Data collection	2
Define	- Sharing what to have learned or observed through fieldwork - Mapping the journey a patient experiences after facing a safety-related problem using drawing or memo notes	Patient journey map	1
	- Finding patterns on the map and giving them meaning	Description	1
	- Defining insights from the patterns and meanings and discussing a shift in perspectives	Description	1
	- Presenting drawings or diagrams to help express insights	Drawing or diagram	
	- Defining patient safety issues and generating ideas for solving problems using the "how might we" statement	"How might we" statements	1
	- Generating specific ideas for problem-solving through brainstorming using memo notes	Many ideas	1
	- Selecting 2–3 ideas that team members are most interested in	2~3 ideas	1
	- Develop one idea using drawing or Post-it notes	Visualized one idea	1
	- Checking the feasibility of the idea, including its value, strengths, or obstacles	Description	1
	- Describing the name of the idea and how it works, and sketching its shape	Sketch of the idea	
	- Identifying which stakeholders within the medical institution are there to make the idea a reality	Description	1
Prototyping	- Creating a prototype and photographing the step-by-step production process	Drawing of prototype	8
Evaluation	- Reviewing the prototype to see if it was created as the team intended, and how users would evaluate it	Description	3

A total of 30 h, including orientation and program evaluation time.

Table 3
Construction of case-based learning tutorial.

Stage	Contents	Time (hour)
Brain-storming	- Sharing experiences related to patient safety during clinical practices - Describing thoughts and feelings about the above experiences	1
Scenario 1	- A case of transfusion of the wrong blood type to a patient admitted to the intensive care unit after undergoing surgery in a traffic accident - After about 70 mL of blood had been administered, the patient's breathing became unstable, and only then did a nurse realize that the patient was being administered the wrong blood	6
Scenario 2	- A case of inserting a nasogastric (NG) tube into a patient with intestinal obstruction - After the doctor communicates with the nurse about who the patient is, the NG tube is inserted into the patient - Later, the nurse finds out that the NG tube is being inserted into the wrong patient	6
Scenario 3	- A case that surgery was completed with a surgical instrument remaining in the abdominal cavity a patient undergoing a surgery - In the process of changing nurses during the surgery, instruments counting was not taken over - Confirmed the instrument missing at the central supply room	6
Scenario 4	- A case of fall in an elderly patient with general weakness - Patient falls over the side rail of the bed to go to the bathroom at dawn	6
Scenario 5	Medication errors - One milligram of a drug is administered as one ampule - Administration of pethidine different from the prescribed drug, morphine – 500 mL fluid is administered in 5 h to a 3-year-old who underwent heart valve surgery - The drug was administered to the wrong patient whose name is similar - A patient is not given medication because the patient is not in a room during drug administration time - A drug to be administered via intramuscular injection is administered via intravenous injection - The drug is administered differently from the prescribed time	3

A total of 30 h, including orientation and program evaluation time.

Korean version [25]. NCRS is a 5-point Likert-type scale for a total of 15 items, with a higher score meaning a higher clinical reasoning competence. Cronbach's alpha values for four times of measurements ranged from 0.924 to 0.967 in this study.

2.5.2. Patient safety competency

Patient Safety Competency Self-Evaluation (PSCSE) [26] was used to determine patient safety competency. PSCSE has been validated in Korean nursing students [26]. PSCSE is a 5-point Likert-type scale for three categories (knowledge, skill, attitudes) with a total of 41 items. A higher score meant a higher patient safety competency. In this study, Cronbach's alpha values for four times of measurements ranged from 0.767 to 0.851 for knowledge, from 0.927 to 0.959 for skills, and from 0.789 to 0.931 for attitudes.

2.5.3. Professional socialization

Professional socialization was measured using a questionnaire developed by researchers of the present study. The questionnaire is scored on a 6-point Likert-type scale with four subscales, including ethical practice and reflection (EP), perception of respect and recognition (RR), clinical competency based on leadership (CL), and desires and motivation for professional development (DM) for a total of 24 items, with higher scores indicating a higher level of professional socialization. Items on the questionnaire were generated by interviewing 32 nurses and by literature reviews. It was validated using exploratory factor analysis and confirmatory factor analysis, for which 881 nurses participated in the survey. These 24 items were revised to a final set of 21 items by incorporating multitrait scaling techniques and the heterotrait-monotrait ratio of correlations for assessing validity in tool validity testing study [27]. In this study, Cronbach's alpha values for four times of measurements ranged from 0.761 to 0.902 for EP, from 0.810 to 0.910 for RR, from 0.754 to 0.829 for CL, and from 0.789 to 0.839 for DM.

2.6. Intervention and data collection procedure

Participants were recruited from three nursing schools in January 2020. DT and CBL interventions were performed at a researcher-affiliated university in February 2020. Participants were allowed to freely apply to an intervention group (DT or CBL group) or a no-intervention group (control group) through study recruitment notification via 3rd year nursing students' group chat networks. It was recommended that students who could participate in the 30-h, 5-day program could faithfully apply to intervention groups. Participants who applied to the intervention group were subgrouped by researchers into in either the DT group or the CBL group (four to six in each group) according to the order in which they were enrolled. Therefore, each intervention group consisted of four subgroups of 4–6 participants. DT and CBL educational programs were conducted by a researcher who was trained in DT with experience of operating CBL. Data collection was done by a research assistant blinded to intervention and control group assignment status.

Orientation was conducted for each subgroup (DT or CBL) after baseline data collection. The intervention was conducted for each subgroup for 30 h over five days. Each subgroup carried out activities according to provided modules. While monitoring activities of the subgroups, we checked and gave feedback on results of each step. Ideas from the four DT groups included ways to improve post-discharge medication adherence, ways for health professionals to check patients' understanding of education, ways for patients to

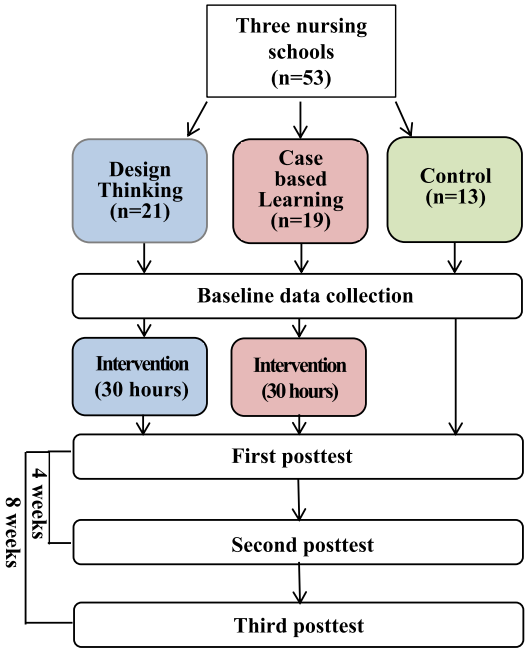

Fig. 1. Study design

understand the risk of infection, and ways to improve health professionals' use of protective equipment. Prototypes were submitted as drawings of mobile applications, pamphlets, social media, and sensor devices where ideas were implemented. The CBL group described a discussion on questions presented for each case and submitted them as the final result.

When programs were finished, the first posttests were conducted. The second posttests were conducted four weeks later and the third posttests were conducted eight weeks later. Data collection for the control group, which received no intervention, was conducted via email at a time similar to that for the intervention group (Fig. 1). All participants in intervention and control groups faithfully

Table 4
Effects of Patient's safety education using design thinking and case-based learning ($N = 53$).

Variables	Group	Baseline	Posttest 1	Posttest 2	Posttest 3	Source	χ^2	p
		M±SE/ Median [IQR]	M±SE/ Median [IQR]	M±SE/ Median [IQR]	M±SE/ Median [IQR]			
		F/χ^2 (p)	F/χ^2 (p)	F/χ^2 (p)	F/χ^2 (p)			
NCRS	DT (n = 21)	3.20 ± 0.47	3.61 ± 0.42	3.84 ± 0.42	3.94 ± 0.50	Group	1.017	0.602
	CBL (n = 19)	2.99 ± 0.38	3.56 ± 0.52	3.78 ± 0.43	3.93 ± 0.46	Time	64.819	<0.001
	Control (n = 13)	3.33 ± 0.86	3.50 ± 0.93	3.49 ± 0.91	3.59 ± 1.02	G*T	15.432	0.017
		1.472 (0.239)	0.115 (0.891)	1.583 (0.215)	1.305 (0.280)			
PSCSE: knowledge	DT (n = 21)	2.91 ± 0.63	3.68 ± 0.38	3.90 ± 0.56	4.04 ± 0.56	Group	1.920	0.383
	CBL (n = 19)	2.65 ± 0.59	3.77 ± 0.59	3.89 ± 0.46	4.11 ± 0.48	Time	111.485	<0.001
	Control (n = 13)	3.56 ± 0.59	3.92 ± 0.57	3.78 ± 0.60	3.73 ± 0.55	G*T	42.824	<0.001
		8.985 (<0.001)	0.887 (0.418)	0.228 (0.797)	2.179 (0.124)			
PSCSE: skill	DT (n = 21)	3.65 ± 0.47	3.98 ± 0.51	4.05 ± 0.53	4.13 ± 0.54	Group	5.203	0.074
	CBL (n = 19)	3.05 ± 0.51	3.79 ± 0.50	3.93 ± 0.41	4.16 ± 0.49	Time	75.904	<0.001
	Control (n = 13)	3.64 ± 0.43	3.70 ± 0.74	3.52 ± 0.69	3.74 ± 0.60	G*T	43.606	<0.001
		9.466 (<0.001)	1.082 (0.347)	4.020 (0.024)	2.817 (0.069)			
PSCSE: attitudes	DT (n = 21)	4.53 ± 0.32	4.62 ± 0.32	4.51 ± 0.38	4.59 ± 0.40	Group	0.022	0.989
		4.57 [0.39]	4.64 [0.61]	4.43 [0.46]	4.71 [0.50]			
	CBL (n = 19)	4.41 ± 0.32	4.59 ± 0.31	4.55 ± 0.42	4.69 ± 0.29	Time	7.899	0.048
		4.50 [0.64]	4.64 [0.57]	4.57 [0.86]	4.79 [0.43]			
	Control (n = 13)	4.39 ± 0.96	4.65 ± 0.25	4.59 ± 0.39	4.66 ± 0.31	G*T	5.681	0.460
		4.64 [0.57]	4.71 [0.57]	4.71 [0.57]	4.79 [0.36]			
		2.967[a] (0.227)	0.361[a] (0.835)	0.515[a] (0.773)	0.538[a] (0.764)			
PS: EP	DT (n = 21)	5.17 ± 0.52	5.29 ± 0.60	5.31 ± 0.55	5.33 ± 0.69	Group	6.874	0.032
			5.50 [0.75]	5.33 [0.67]	5.50 [1.00]			
	CBL (n = 19)	5.00 ± 0.50	5.26 ± 0.47	5.46 ± 0.38	5.55 ± 0.43	Time	7.924	0.048
			5.17 [0.50]	5.50 [0.50]	5.50 [0.67]			
	Control (n = 13)	5.62 ± 0.30	5.65 ± 0.23	5.47 ± 0.41	5.47 ± 0.45	G*T	33.269	<0.001
			5.67 [0.33]	5.50 [0.67]	5.50 [0.75]			
		6.830 (0.002)	5.669[a] (0.059)	0.251[a] (0.882)	0.336[a] (0.845)			
PS: RR	DT (n = 21)	4.17 ± 1.06	4.46 ± 0.95	4.43 ± 1.03	4.67 ± 1.04	Group	1.597	0.450
		4.33 [1.67]			5.00 [1.50]			
	CBL (n = 19)	4.14 ± 0.60	4.61 ± 0.91	4.81 ± 0.80	4.91 ± 0.96	Time	23.968	<0.001
		4.00 [1.00]			5.00 [1.67]			
	Control (n = 13)	4.28 ± 1.02	4.36 ± 0.88	4.08 ± 0.89	4.36 ± 0.80	G*T	28.361	<0.001
		4.33 [1.33]			4.00 [1.17]			
		0.106[a] (0.948)	0.318 (0.729)	2.466 (0.095)	2.616[a] (0.270)			
PS: CL	DT (n = 21)	4.33 ± 0.55	4.78 ± 0.72	4.88 ± 0.78	4.97 ± 0.77	Group	5.807	0.055
					4.80 [1.80]			
	CBL (n = 19)	3.83 ± 0.58	4.46 ± 0.55	4.77 ± 0.47	4.87 ± 0.50	Time	58.667	<0.001
					5.00 [0.80]			
	Control (n = 13)	4.71 ± 0.69	4.89 ± 0.58	4.82 ± 0.56	4.78 ± 0.60	G*T	29.308	<0.001
					4.80 [0.70]			
		8.711 (0.001)	2.132 (0.129)	0.146 (0.864)	0.583[a] (0.747)			
PS: DM	DT (n = 21)	4.85 ± 0.76	5.06 ± 0.74	5.08 ± 0.72	5.02 ± 0.75	Group	7.909	0.019
		5.00 [1.25]	4.75 [1.38]					
	CBL (n = 19)	4.72 ± 0.42	5.09 ± 0.55	5.24 ± 0.51	5.24 ± 0.49	Time	10.212	0.017
		4.75 [0.50]	5.00 [0.75]					
	Control (n = 13)	5.50 ± 0.48	5.40 ± 0.50	5.40 ± 0.66	5.50 ± 0.51	G*T	13.946	0.030
		5.75 [0.88]	5.50 [0.63]					
		11.225[a] (0.004)	2.648[a] (0.266)	1.031 (0.364)	2.453 (0.096)			

CBL = case-based learning; CL = clinical competency based on leadership; DM = desire and motivation for professional development; DT = design thinking; EP = ethical practice and reflection; G = group; IQR = interquartile range; M = estimated mean; NCRS = nurses clinical reasoning scale; PS = professional socialization; PSCSE = patient safety competency self-evaluation; RR = experience of respect and recognition; SE = standard error; T = time.

[a] Kruskal-Wallis test.

responded to a total of four times of data collections.

2.7. Data analysis

Data were analyzed using the SPSS version 24. For descriptions of NCRS, PSCSE, and professional socialization, the mean or median was calculated depending on whether normality was met. In this study, repeated measure analysis of variance (ANOVA) was not used because baseline homogeneity or normality was not satisfied for some dependent variables. Effects of educational programs over 4-time points were analyzed using a generalized estimating equation (GEE). An ANOVA or Kruskal-Wallis test was used to analyze differences among the three groups at each time point.

2.8. Ethical consideration

This study was approved by the Institutional Review Board (IRB) of the University of Ulsan (IRB No: 1040968-A-2020-002). It was

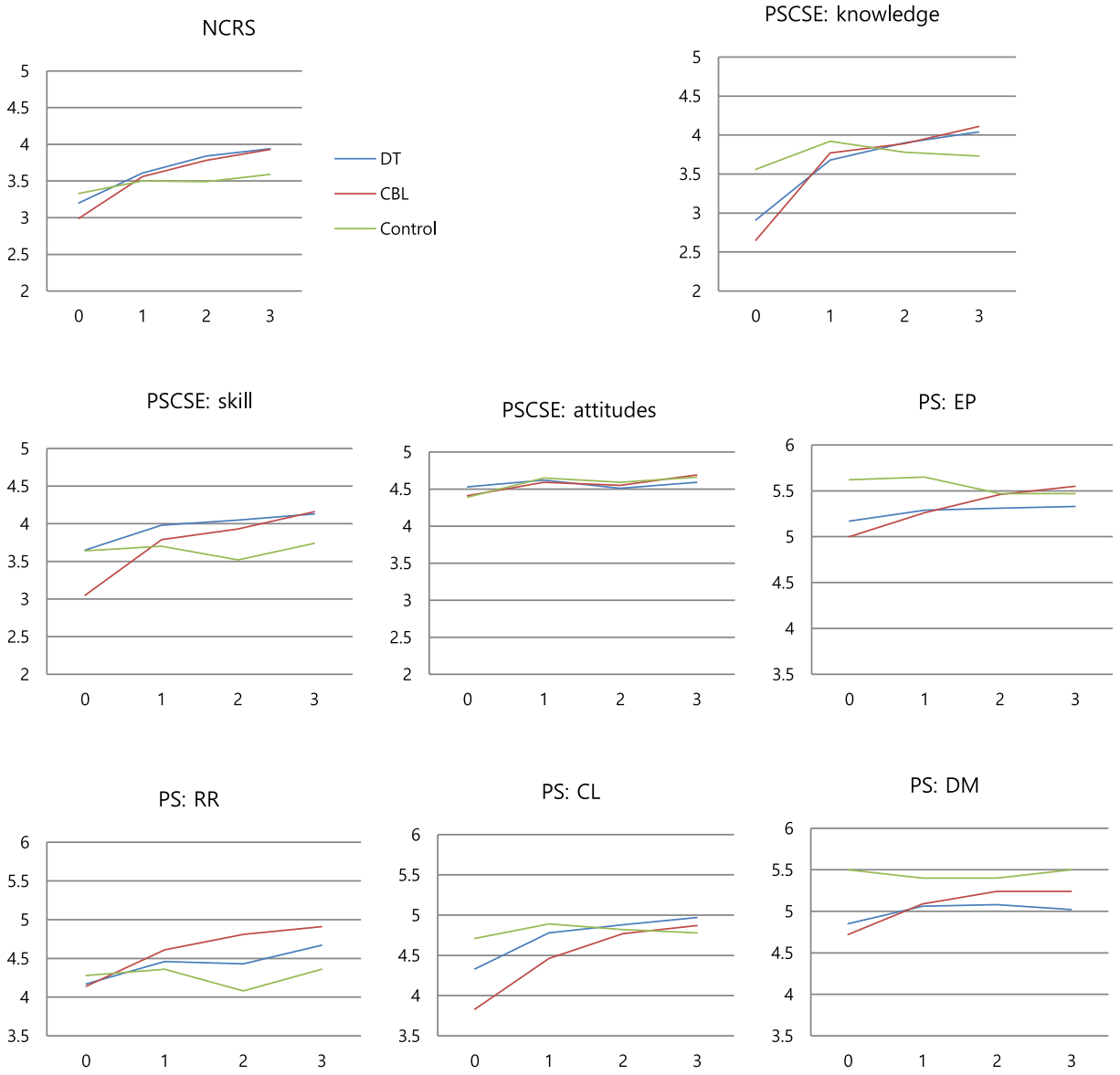

Fig. 2. Changes in NCRS, PSCSE, and PS over time in the three groups. The X-axis denotes time, with 0 being the baseline, 1 being posttest 1, 2 being posttest 2, and 3 being posttest 3. The Y-axis denotes mean scores. (CBL = case-based learning; CL = clinical competency based on leadership; DM = desire and motivation for professional development; DT = design thinking; EP = ethical practice and reflection; NCRS = nurse clinical reasoning scale; PS = professional socialization; PSCSE = patient safety competency self-evaluation; RR = experience of respect and recognition).

carried out in compliance with IRB guidelines and the Declaration of Helsinki. We received written consent from all participants. Transportation, meals, stationery, and participation fees were provided to intervention groups. The control group was provided with four survey participation fees.

3. Results

Table 4 and Fig. 2 show the effects of the interventions.

3.1. Effects of interventions on clinical reasoning competence

The interaction effect of intervention was significant ($\chi^2 = 15.432$, $p = 0.017$). The NCRS was increased continuously in both DT and CBL groups. It was greater than that of the control group. There was no significant difference in the effect between DT and CBL.

3.2. Effects of interventions on patient safety competency

Among PSCSE, there were significant interaction effects in knowledge ($\chi^2 = 42.824$, $p < 0.001$) and skill ($\chi^2 = 43.606$, $p < 0.001$). The knowledge score in the control group had little difference from the baseline. However, it continued to improve in both DT and CBL groups. The skill score also showed a similar pattern to knowledge score. The CBL group showed a higher improvement in skill than the DT group. DT and CBL had no significant effect on attitude improvement ($\chi^2 = 5.681$, $p = 0.460$).

3.3. Effects of interventions on professional socialization

There were significant interaction effects in all subscales of professional socialization. In EP, CL, and DM, scores of the control group were significantly higher than those of the DT group and the CBL group at baseline. However, scores of the control group were not changed after the intervention, whereas scores of other groups were steadily increased. Therefore, interaction effects were significant in EP ($\chi^2 = 33.269$, $p < 0.001$), CL ($\chi^2 = 29.308$, $p < 0.001$), and DM ($\chi^2 = 13.946$, $p = 0.030$). In the case of RR, there were no significant differences among the three groups at baseline. After interventions, the score of the control group decreased whereas scores of other groups increased. Thus, there was a significant interaction effect ($\chi^2 = 28.361$, $p < 0.001$). Especially, CBL was more effective in improving all subscales of professional socialization than DT.

4. Discussion

This study showed that DT, a newly applied educational method for developing clinical reasoning and patient safety competencies in nursing students, was not inferior to CBL, an existing effective educational method. CBL has already been proven to be an effective educational method for improving academic performance and case analysis ability of healthcare students through a meta-analysis [8]. Findings of this study provided an opportunity for nurse educators to be interested in and utilize the DT method not only in schools, but also in clinical practice.

DT is one of the most promising approaches to understanding patient experience. It is becoming a creative and human-centered problem-solving approach in healthcare where improving patient experience is becoming increasingly important [9]. Benefits of applying DT to health professions education are that students can acquire the value of collaborative problem-solving and diversity of thought [10]. Therefore, DT can be an effective educational method in patient safety management where teamwork, communication, and collaboration are essential [28].

Findings of this study showed that patient safety education utilizing the DT was effective in improving competencies in the field of clinical reasoning and patient safety knowledge. Studies that apply DT as an educational strategy or program for health profession education tend to focus on early stages of the DT process, inspiration, and ideation, with fewer studies attempting later stages of implementation [10]. However, this study progressed to the prototyping stage just before implementation. This might have contributed significantly to improving clinical reasoning competency and patient safety competency.

DT emphasizes innovation and collaboration [10.29]. It is a great way to develop innovative and empathetic nurses [29]. Applying the MakerSpace environment based on the DT process to interdisciplinary classes including nursing, pre-professional health, and engineering to develop innovative solutions to community health problems can result in increased confidence in ethical reasoning and a threefold increase in students rating ethical reasoning as their most important skill [30]. In this regard, it would be interesting to measure whether an educational method utilizing DT can improve nursing students' and nurses' innovativeness, collaboration, and ethics. The concept of professional socialization measured in this study also includes attributes such as ethical attitudes, empathy, peer support, and proactive actions to improve the culture and environment [27]. In this study, the DT group showed ups and downs in professional socialization scores, while the CBL group showed improvement and maintenance of professional socialization scores, suggesting that CBL is more effective than DT in improving professional socialization. Even in patient safety attitudes, the results of this study showed no significant difference between the intervention and control groups ($\chi^2 = 5.681$, $p = 0.460$). However, in the CBL group, attitude scores increased significantly in the within-group analysis ($\chi^2 = 7.899$, $p = 0.048$). These excellent educational aspects of CBL allow it to be frequently used in education. Thus, students are used to learning in this way. However, DT is new. Students are not familiar with it. They might experienced trial and error in their learning process. A study of the relationship between clinical competence and professional socialization in nursing students has found that for fourth-year students with more exposure and nursing

experience in clinical practice, higher clinical competence is associated with higher professional socialization [19]. However, for third-year students with less clinical experience, clinical competence and professional socialization showed no relationship [19]. Similarly, in this study, CBL was more effective for professional socialization than DT likely because CBL learning was already familiar to students, which could facilitate the achievement of learning objectives. Since DT was effective in improving clinical reasoning competency and patient safety competency in this study, continued use of DT in future educational settings is likely to improve professional socialization. To this end, nurse educators should strive to learn and practice DT as a human-centered problem-solving method, which will promote innovation in the field [31].

In this study, DT was effective in increasing reasoning and patient safety knowledge capabilities, but compared to CBL, CBL showed better results. Nevertheless, nurse educators need to not only utilize existing educational methods but also develop a variety of more innovative and creative educational methods to train nurses who can identify and solve the complex and diverse needs of patients. This study provides clues that DT can be used as one such educational method. As DT continues to be used in nursing education, it is expected that the method will become more sophisticated, and its effectiveness will further increase.

Limitations of this study are as follows. First, baseline PSCSE and professional socialization scores of participants were not homogeneous because the assignment to two intervention groups and a control group in this study was not randomized. Although the four-year nursing curriculum in Korea is somewhat consistent from school to school through standards set by the Korean Accreditation Board of Nursing Education, we were unable to control for factors that might have influenced the results of this study, such as school situation and extracurricular program experiences of students in this study. In addition, students in this study were mostly female, and the sample size was relatively small compared to other educational intervention studies. Thus, the results of this study cannot be generalized to all nursing students. We suggest additional studies with a larger sample than this study.

5. Conclusions

This study examined effectiveness of patient safety education using DT and CBL methods on nursing students' clinical reasoning competency, patient safety competency, and professional socialization. Results showed that DT, a new educational method, was as effective as CBL, a traditional educational method, in clinical reasoning competency and knowledge domain of patient safety competency. In this study, DT was effective only in some competencies and did not show a better effect than CBL. Nevertheless, in the healthcare field, where improving patient experience is becoming increasingly important, there is a need to explore various educational methods to train nursing students who can take a creative and human-centered problem-solving approach, and DT is one of them. DT is a new educational method in nursing. Therefore, better learning outcomes can be achieved if nurse educators develop, apply, modify, and supplement curricula using DT not only in the field of patient safety but also in various patient care fields.

Meanwhile, in this study, patient safety education improved nursing students' competencies and professional socialization. Future studies are needed to develop other topics for DT education to confirm its effect on competencies and professional socialization. Studies comparing the DT method with other teaching methods other than CBL are also needed.

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Data availability statement

The dataset supporting the findings of this study is available from the corresponding author upon reasonable and justified request.

CRediT authorship contribution statement

Seongmi Moon: Writing – review & editing, Writing – original draft, Validation, Supervision, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Soo Jung Chang:** Writing – review & editing, Writing – original draft, Validation, Formal analysis.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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