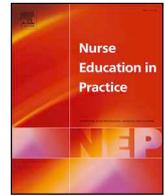




ELSEVIER

Contents lists available at ScienceDirect

Nurse Education in Practice

journal homepage: www.elsevier.com/locate/nepr

Original research

Effects of simulation-based learning on nursing student competences and clinical performance

Bih-O. Lee^a, Hwey-Fang Liang^b, Tsui-Ping Chu^c, Chang-Chiao Hung^{d,*}^a College of Nursing, Kaohsiung Medical University & Department of Nursing, Kaohsiung Medical University Hospital, Taiwan^b School of Nursing, Chang Gung University of Science and Technology at ChiaYi Campus, Taiwan^c Department of Nursing, ChiaYi Chang Gung Memorial Hospital, ChiaYi, Taiwan^d School of Nursing & Nursing Department, Chang Gung University of Science and Technology & ChiaYi Chang Gung Memorial Hospital, ChiaYi, Taiwan

ARTICLE INFO

Keywords:

Simulation-based learning
Nursing student competency
Clinical performance
Simulation-based learning evaluation scale
Experiential learning theory

ABSTRACT

The aims of this study were to explore the effects of simulation-based learning (SBL) on nursing student competences and performance in the clinical setting.

A comparison group design was used with data obtained from self-administered questionnaires at the onset and end of the semester. Students' practicum grades were also collected to examine their clinical performance. Four simulated scenarios were added to the course and a Chinese version of the Simulation-Based Learning Evaluation Scale (SBLES) was distributed to the participants. The student practicum evaluation form was used to collect the participants' practicum grades. Data analyses included descriptive statistics, paired *t*-test, and analysis of covariance (ANCOVA).

Positive, significant differences were found in five competences in the test group. In the comparison group, results in the professional knowledge and nursing process subscale showed significant differences, and no significant difference was found in the patient safety, communication, and attitude of reflection subscales. The students in the test group perceived greater competences than those in the comparison group. Finally, no significant findings were found in clinical performance between two groups.

The findings showed that SBL is seen as an attractive teaching strategy for students' learning as part of their curriculum and that the effects of SBL on clinical practice need further examination.

1. Introduction

Various factors – such as high patient acuity, nursing shortage, short length of stay, and increased acute care admissions – increase the adaptation challenge of new nurses in a clinical setting. To link nursing education to the clinical practice settings, one teaching strategy, simulation-based learning (SBL), is considered to improve student learning efficacy and has been combined with the normal nursing curricula. Nursing students who experience SBL show increased knowledge and self-confidence, satisfaction, critical thinking disposition, assessment and psychomotor skills. They also demonstrate increased problem-solving ability, communication competency, cooperation, leadership, and delegation skills (Bliss and Aitken, 2018; Boling and Hardin-Pierce, 2016; Curl et al., 2016; Flood and Higbie, 2016; Kaddoura et al., 2016; Kimhi et al., 2016; Mager and Campbell, 2013; Moreland et al., 2012). Students have also reported improved performance in relation to responding to deterioration in patients'

conditions and their own retention in the health care system (Leonard et al., 2010; Sapiano et al., 2018).

Although numerous studies have shown that SBL benefits students' learning they have invariably examined the efficacy of SBL (Foronda et al., 2013; Weaver, 2011). It remains controversial whether SBL narrows the gap between “knowing” and “doing,” with evidence lacking as to whether SBL affects student behaviors in actual clinical settings (Norman, 2012; Weaver, 2011). Without this evidence, curricula learning objectives are at risk of being misdirected, and school policy that encourages lecturers to embed multiple instructional strategies in typical lectures is unwarranted.

This study designed and implemented four clinical scenarios into an advanced acute care course and then followed up the students' perceptions of nursing competence after completing clinical practicum to see the degree of consistency between “knowing” and “doing.” Traditional learning involves a teacher-centered learning environment in which an instructor teaches and the student passively learns. Kolb

* Corresponding author. 2, Chia-Pu Road, West Sec., Putz, Chia-Yi, 613, Taiwan.
E-mail address: dv749@hotmail.com (C.-C. Hung).

(1984) Experiential Learning Theory (ELT) (Rumelt) emphasizes a learner-centered style and focuses on the learner and the learning process. The ELT consists of four stages, namely concrete experience, reflection, abstract conceptualization, and active experimentation. In the stages of concrete experience and reflection, a learner experiences or operates actual events and is continuously thinking and observing the learning process to gain learning content. Abstract conceptualization is used to internalize the learning content into the learner's knowledge and contributes to changes in the learner's behavior, and finally leads to active experimentation (Kolb, 1984). In the learning cycle, the learner will obtain new knowledge and abilities with learning considered a continuous process in ELT. Canales and French (2003) defined experiential learning as "the cyclical process wherein people view their experiences as opportunities to learn, integrate those experiences into their education and engage in subsequent action based on the integrations" (p. 1232). In nursing, simulation is defined as "activities that mimic the reality of a clinical environment and are designed to demonstrate procedures, decision-making, and critical thinking through techniques such as role-playing and the use of devices such as interactive videos or mannequins" (National Council State Board of Nursing, 2005, p. 2). Actual practice, role play, or simulation are essential elements of experiential learning.

Simulation training involves simulated scenarios, using life-size full-body simulators equipped with computer software that can replicate human physical and physiological signs and symptoms (e.g., high blood pressure or low oxygen saturation), and a simulation laboratory that is set up as an actual clinical setting. In simulation training, the instructor designs simulated scenarios and manipulates a simulator by using computer software to present the simulated situation. People participate in the simulated scenarios and react to the simulated events and obtain experience. Following the scenario, the instructor guides participants to proceed through experiences on which they then reflect. Reflection, or debriefing, encourages students to think through the experience step-by-step and integrates experience with the cognitive framework. Participants later involved in a similar situation might alter their behavior according to new insights. Simulated training has been shown to improve key behaviors in aviation (Helmreich and Foushee, 1993) and has also been adopted into nursing education studies (Curl et al., 2016; Kaddoura et al., 2016; Kimhi et al., 2016; Mager and Campbell, 2013; Moreland et al., 2012).

Nursing students at different learning levels can benefit from SBL. Leonard et al. (2010) recruited 48 undergraduate nursing students from different levels into interprofessional teams, where all students experienced the same acute pediatric and adult simulation scenarios. Leonard et al. found that students with different levels of education could recognize their typical nursing role. For instance, first-year students focused on professional skills, such as basic assessment and communication, and senior students addressed advanced or administrative skills, such as within the leadership role. To answer a question, "What is the effect of simulation training on knowledge and confidence?", Boling and Hardin-Pierce (2016) reviewed and synthesized 17 studies from two literature databases and found that all 17 studies, and 13 of the 17 studies, demonstrated an improvement in knowledge and confidence, respectively. Curl et al. (2016) conducted a quasi-experimental study and found that students in an experimental group had significantly higher scores on the pre-graduation exit exam compared with those in the control group.

Few studies have shown contradictory findings to such studies. Feingold et al. (2004) designed two clinical scenarios and implemented them into an advanced acute care adult course for 65 senior students. Their findings showed that approximately half of the participant students agreed that they could transfer skills learned from scenarios to an actual clinical setting. Griggs (2003) conducted a comparison study and found that students' clinical performances did not differ between test and comparison groups. A more recent study compared the educational outcomes of students who participated in 10 percent, 25 percent, and 50 percent simulation in lieu of clinical time and found that clinical competency and nursing knowledge assessments did not differ among these groups (Hayden et al., 2014).

Based on the above discussion, this study aims to (1) explore the effects of SBL on students' perception of nursing competence before and after receiving SBL, (2) compare the differences in student perception of nursing competence between SBL and a typical course, and (3) explore the effects of SBL on student performance in the clinical settings.

2. Methods

2.1. Research design

This prospective interventional study included two phases with Phase I focused on addressing aims 1 and 2. Four simulated scenarios were added to the study courses and a pretest–posttest comparison group design was used with students undertaking self-report surveys at the onset and on completion of the semester. In Phase II, a comparison group design was used for comparing the students' performance in the clinical setting, addressing aim 3.

2.2. Setting and sample

This study was conducted at a university of science and technology, located in the northern part of Southern Taiwan. The study setting was a simulation center outfitted with one Laerdal SimMan manikin in an intensive care unit (ICU)-like laboratory similar to that in a hospital at the study university. The simulation center had one observation and debriefing room, one simulation patient room, one operation room, and three Objective Structured Clinical Examination (OSCE) rooms.

All the senior students within a 2-year nursing baccalaureate program, including day and evening divisions, who chose to enroll in an advanced acute care adult course in Fall 2016 were invited to participate in this study. To consider the completion of curricula and consistency of implementing interventions for students to achieve course objectives, one class was designated as the test group (day shift class) and one as the comparison group (night shift class). Demographic information for the second-year students of a 2-year nursing bachelor program indicated that 90% were female and their average age was 21–22 years. To enroll in an advanced acute care adult course, students had to have completed two adult health nursing courses and one physical assessment course. According to calculations conducted using G*power software, a total sample of 101 in two groups generated a power of .80, medium effect size of 0.25 and alpha of .05 (Cooper and Hedges, 2009; Faul et al., 2009). That is, each group consisted of 50 participants and this met the statistic power required to compare the difference between two means.

In accomplishing aim 3, because the hospitals could only provide 8 ICU units for practicum the students in these units were equally assigned to day shift and night shift classes. The participants who completed the advanced acute care adult course in either day shift or night shift classes were randomly assigned into an ICU unit or general medical-surgical unit to complete their practicum. All students are required to complete a 198-h clinical practicum. The practicum ICUs and medical-surgical units were in three hospitals characterized as being non-government, not-for-profit, accredited acute care, and teaching hospitals.

2.3. The intervention

2.3.1. Identifying nursing competence

This study was a series design and the competences identified by the panel conducted from the author's previous study comprised (a) applying professional knowledge (i.e. biomedical and nursing knowledge), (b) implementing technical skills, (c) applying the nursing process (problem-solving ability), (d) demonstrating the ability to communicate with other health care team members and patients, and (e) critical thinking competence (Hung et al., 2016). The simulated scenarios were designed to meet the study objectives that reflect these competences; the evaluated instrument that was developed in the

Table 1
Scenarios and competences.

Scenarios	Competences	Critical events	Student target responses
Cardiogenic shock in anterior wall myocardial infarction	1, 2, 3, 4, 5	1. Unstable angina 2. Cardiogenic shock attack 3. Cardioversion need	1. To assess severity, radiation of pain using enquiry, auscultation, and noting electrocardiogram (EKG) monitor. 2. To give medication by physician orders. 3. To count frequency of PVCs on the EKG monitor. 4. To assist implementation of cardioversion.
Respiratory system and assessment	1, 2, 3, 4, 5	1. Unstable respiratory pattern 2. Respiratory distress 3. Respiratory failure	1. To apply oxygen and administer the bronchodilator via nebulizer, monitor for side effects of medication 2. To assess circumoral and peripheral cyanosis, report findings to the healthcare provider, and administer physician orders 3. To assist placement of endotracheal tube.
Resuscitation and assessment	1, 2, 4	1. Condition stable 2. Code blue 3. Asystole and death	1. To administer physician assessment and routine care. 2. To judge condition deterioration with poor vital signs and other vital conditions, call code blue, and give basic life support (BLS) and advanced cardiac life support (AVLS) protocols. 3. To continue BLS and AVLS protocols, collaborate effectively with the healthcare team and provide emotional support for family.
Assessment	1, 2, 3, 4, 5	1. Patient admission 2. Patient blood pressure drop 3. Handover	1. To obtain a comprehensive focused history. 2. To recognize normal and abnormal assessment findings. 3. To complete APACHE II sheet. 4. To deal with low blood pressure situation. 5. To complete handover using ISBAR.

Note: Competency 1 = Professional knowledge; Competency 2 = Technical skills; Competency 3 = Nursing process; Competency 4 = Communication; Competency 5 = Critical thinking.

PVCs = Premature Ventricular Contractions; EKG = Electrocardiogram; APACHE II = Acute Physiology and Chronic Health Evaluation.
ISBAR = Introduction, Situation, Background, Assessment, and Recommendation.

previous study was also based on the above competences (Hung et al., 2016).

2.3.2. Scenario development

Within the study school, the content of an advanced acute care adult course comprised five units—assessment, shock, respiratory system, resuscitation, and conflict and management—we therefore developed four scenarios in relation to the course content and all were completed. These simulated scenarios were sent to an expert panel for judging their content according to the plan of the study. Five external experts, two physicians, one practitioner, one school lecturer, and one clinical preceptor who all had backgrounds in ICU experiences and simulation research or education were invited to assess the preliminary content validity. The items that the experts rated for the content of scenarios were in relation to five study competences. The content validity index (CVI) for each competency ranged from 0.75 to 0.96, and the average of CVI for the four scenarios was 0.88. Table 1 shows the scenarios that consisted of the competency, critical events, and student target responses.

2.3.3. Intervention implementation

2.3.3.1. Test groups. The four scenarios were lodged in 36 h of an advanced acute care adult course. Each simulation included three phases of introduction, scenario display, and debriefing and required approximately 1.5 h to complete. Students in the test group were randomly allocated into 10 teams for the semester. The course instructor provided a verbal introduction of the semester to the students. An overview of the patient simulator and the video-recording system were presented to the students in class, even if they had previously used the simulator. On simulation days, the course instructor presented an overview of the scenario and described specific roles (e.g. primary nurse or documenter) for the student who acted as a health care provider. The course instructor subsequently led the students into the simulation patient's room to care for the patient. Only one group had hands-on involvement, with the others to observe the scenario progress in the observation room by using a one-way mirror and monitors. Each student team took turns with the four scenarios.

Each simulated scenario involved one to two critical events lasting between 10 and 15 min, depending on the student responses. During the simulation, the course instructor ran the manikin and the simulator

equipment from the operation room. The instructor controlled the progress of the simulated scenarios by using a verbal stream to immediately respond to student questions and actions. A verbal debriefing was held immediately following the simulated scenario. Because we used video-assisted verbal discussion for the debriefing phase, we took 30 min to complete this phase for each simulation. During the debriefing phase, the instructor encouraged students to express their feelings and experiences, identify and analyze strengths and weaknesses, reflect on how to improve shortcomings, and finally generalize the action to improve their clinical practices. Each student and instructor involved in this study program was required to sign a consent form allowing them to be photographed.

No grades were given for the simulation, but the content was tested in the mid-term and final examinations. Students who were absent were required to make up the simulation.

2.3.3.2. Comparison groups. Students in the comparison group were also randomly divided into 10 teams in the class. The course instructor introduced the course flow to the students for the entire semester. Typical courses and case study discussions were administered to students. The case study was modified from the simulation scenario, and each case study discussion took 1.5 h to complete.

2.4. Instrument

The Simulation-Based Learning Evaluation Scale (SBLES) was used to obtain participant perceptions of nursing student competence with the simulation experience before and after participating in this study (Hung et al., 2016). The SBLES consists of 37 items in five subscales: nursing process (9 items), patient safety (8 items), professional knowledge (7 items), communication (7 items), and attitude of reflection (6 items). The SBLES exhibits qualified reliability and favorable convergent and discriminant validity (Hung et al., 2016). Cronbach's alpha (α) for five competences and the entire scale were: nursing process ($\alpha = 0.86$), patient safety ($\alpha = 0.79$), professional knowledge ($\alpha = 0.85$), communication ($\alpha = 0.82$), attitude of reflection ($\alpha = 0.88$), entire scale ($\alpha = 0.87$). These values indicate acceptable levels of reliability.

The student practicum evaluation form was used to collect the participants' practicum grades that represented their clinical

performance in ICU. This evaluation form had already been uniquely designed by the study school and all clinical preceptors use it to score the students' performance on completion of a clinical practicum in ICU. This evaluation form comprises items for evaluating student competence and attitude. Because the competences include measurement outcomes, the items related to attitude – such as accountability, caring, or life-long learning – were excluded. The application of professional knowledge (8 points) and skills (22 points), nursing process (20 points), communication (10 points), and critical thinking (15 points) related to competences were included for a total grade of 75 points. In general, this form is not used for research in the study school so no reliability and validity are reported.

In the study university, there are three clinical preceptors to direct the advanced acute care practicum. All these preceptors have at least a bachelor's degree, 5 years' experience in ICU, and 3 years' experience in directing the advanced acute care practicum. Before the practicum, we recorded five students' practices in ICU over at least 2 days then played the video to the three preceptors to award these five students' grades as a way to assess inter-rater consistency. The intra-class correlation coefficients (ICC) for five competences were: professional knowledge (ICC = 0.85; $p < .00$), technical skills (ICC = 0.79; $p < .00$), nursing process (ICC = 0.86; $p < .00$), communication (ICC = 0.82; $p < .00$), critical thinking (ICC = 0.88; $p < .00$), total grade (ICC = 0.85; $p < .00$). These values indicate acceptable levels of within-group agreement.

2.5. Data collection

The principal investigator explained the purpose and procedures of this study to the students before the class began. The students were told that they had the right to decline participation in this study. To protect the participants, the survey package included a consent form, the questionnaires, and two reply envelopes. When the participants had completed the consent form and questionnaires, they respectively put the consent form and questionnaires in different envelopes and returned the envelopes to the principal investigator. Regardless of whether students participated in this study or not they were required to complete a 36-h class and a 198-h clinical practicum. Student participation in this study was anonymous to the course instructor to ensure that their course grade would not be affected by their involvement in the study. The instrument was distributed to the participants twice: before the course commenced (pretest) and after the course was completed (posttest). The researchers obtained the participants' practicum grade after they had fulfilled their practicum requirements.

When participants had completed their course, by using a random number table, they were randomly selected by the researchers to practice in an intensive care unit (ICU). After completing 112h of clinical practicum, the researchers collected practice grades that included professional knowledge, technical skills, critical thinking, communication, and nursing process. Processes and data collection were conducted from August 2016 to July 2017.

2.6. Ethical consideration

This study received full ethical approval from the study hospital and university Institutional Review Board (approval No.:103-2270B).

2.7. Data analysis

After data were obtained and examined for missing data and internal consistency, analysis began with descriptive statistics, followed by tests of the research questions using chi-square test, paired *t*-test, Student's *t*-test, and analysis of covariance (ANCOVA). Descriptive statistics included frequencies, percentages, means, and standard deviations. To examine the equivalence between the two groups, descriptive data and chi-square tests were applied. Paired *t*-test was used to examine the difference (within-group effect) between pretest and

posttest scores. The researchers used Student's *t*-test to examine the posttest difference (between-group effect) between two groups and tested practicum grade after the participants completed the practicum training. Finally, ANCOVA was applied to avoid the possibility that pretest scores influenced posttest scores, rather than the intervention, in both the test and comparison groups. The conventional level of $\alpha < .05$ was used to represent statistical significance. SPSS 23.0 was used for all analyses (IBM SPSS Statistics for Windows, 2015).

3. Results

3.1. Demographic characteristics

A total of 105 students (day division: $n = 52$; evening division: $n = 53$) chose to enroll in an advanced acute care adult course in Fall 2016. Fifty-two participants in the day division (test group) received the survey package, and 50 returned the questionnaire (response rate = 96%) with one incomplete questionnaire that was excluded from the analysis. For the evening division (comparison group), 53 packages were sent and 51 were returned (response rate = 96%). Finally, no incomplete questionnaires were found.

Ninety-seven percent of respondents were female, with an average age of 22.2 years ($SD = 3.49$) in the test group. Participants in the comparison group were 3.3 years older than the test group and chi-square test showed significant differences between the two groups (Table 2). No other significant difference was observed between the two groups according to gender, licensure, clinical experience, and simulation experience (Table 2).

3.2. Comparison of two groups

In the test group, the range of paired means for the five student competences was between -0.20 and -0.55 (Table 3). Positive, significant differences were found in five competences in the test group. In the comparison group, the range of paired means was between 0.12 and -0.37 for the five competences (Table 3). Results in the professional knowledge ($t = -5.21$; $p < .000$) and nursing process subscale ($t = -4.85$; $p < .000$) showed significant differences; while in the other three subscales, no significant difference was found in the comparison group. Table 4 shows the posttest result of five competences between two groups, and significant differences were found in patient

Table 2
Participant demographics.

	Total ($n = 100$)		Test group ($n = 49$)		Comparison group ($n = 51$)		<i>p</i> -value
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	
Gender							.86
Male	3	3.0	1	2.04	2	3.9	
Female	97	97.0	48	97.9	49	96.1	
Age (Years)							.03
19–20	56	56.0	46	93.8	13	25.5	
21–22	33	33.0	3	6.12	26	51.0	
> 23	11	11.0	0	0.00	12	23.5	
Clinical experience							.07
none	68	68.0	48	97.9	44	86.27	
< 1 year	10	10.0	1	2.04	4	7.84	
1–2 years	7	7.0	0	0.00	2	3.92	
> 2 years	15	15.0	0	0.00	1	1.96	
Licensure							.61
Yes	99	99.0	49	100.0	50	98.1	
No	1	1.0	0	0.00	1	1.9	
Simulation experience							.76
≤1	16	16.0	9	18.3	7	13.7	
1–2	84	84.0	40	81.6	44	86.3	
≥2	0	0.0	0	0.00	0	0.00	

Table 3
Comparison of pretest and posttest of implementing interventions for test ($n = 49$) and comparison groups ($n = 51$).

	Means (SD)		Mean difference ^a	Paired <i>t</i>	<i>p</i> -value	95% CI
	Pretest	Posttest				
Professional Knowledge						
Test	3.91(0.44)	4.40(0.34)	-0.49(0.53)	-6.45	.000	(-0.64, -0.34)
Comparison	4.08(0.40)	4.45(0.32)	-0.37(0.51)	-5.21	.000	(-0.52, -0.23)
Nursing Process						
Test	3.95(0.39)	4.50(0.34)	-0.55(0.50)	-7.60	.000	(-0.69, -0.40)
Comparison	4.04(0.38)	4.39(0.35)	-0.35(0.51)	-4.85	.000	(-0.49, -0.20)
Patient Safety						
Test	4.36(0.47)	4.61(0.28)	-0.26(0.50)	-3.64	.001	(-0.40, -0.12)
Comparison	4.50(0.48)	4.39(0.46)	0.11(0.64)	1.22	.227	(-0.07,0.29)
Communication						
Test	4.06(0.47)	4.47(0.23)	-0.41(0.50)	-5.84	.000	(-0.56, -0.27)
Comparison	4.16(0.43)	4.01(0.39)	0.14(0.61)	1.67	.101	(-0.03,0.31)
Attitude of Reflection						
Test	4.27(0.52)	4.47(0.33)	-0.20(0.60)	-2.37	.022	(-0.38, -0.03)
Comparison	4.28(0.40)	4.12(0.37)	0.12(0.50)	1.69	.097	(-0.02,0.26)
Total score						
Test	4.11(0.36)	4.49(0.23)	-0.39(0.40)	-6.75	.000	(-0.50, -0.27)
Comparison	4.20(0.39)	4.30(0.28)	-0.09(0.44)	-1.42	.162	(-0.21, -0.04)

^a Pretest scores minus posttest scores. Note: CI = confidence interval.

safety, communication, and attitude of reflection subscales. To avoid the possibility that pretest scores and students' age difference influenced posttest scores, rather than the intervention, in both test and comparison groups the ANCOVA was applied to confirm the results acquired from paired *t* tests. The results showed that posttest scores in five student competences were not affected by pretest scores ($p > .05$) (Table 5). Moreover, interventions influenced the posttest scores of three subscales—patient safety ($F = 9.70$; $p < .002$), communication ($F = 50.36$; $p < .000$), and attitude of reflection ($F = 19.05$; $p < .000$)—and the entire scales ($F = 14.78$; $p < .000$).

The results from comparison of practicum grade between test and comparison groups showed that no significant findings were found in clinical performances: professional knowledge ($F = 0.80$; $p = .375$), technical skills ($F = 0.38$; $p = .539$), Critical thinking ($F = 1.27$; $p = .214$), communication ($F = 2.77$; $p = .102$), Nursing Process ($F = 2.67$; $p = .131$), and total grade ($F = 1.00$; $p = .321$), thus indicating that participants showed similar levels of competence (Table 6). The test of normality showed that all data fitted the assumption of normal distribution ($p = .000$).

4. Discussion

One of the purposes of this study was to explore the effects of SBL on perceptions of student competence. As shown in Tables 3 and 4, all five competences were greater in the posttest in the study group. This meant that the participants in the test group were aware of the progression of five student competences after receiving SBL, and the progression reveals a significant difference between the two groups. This finding

Table 4
Comparison of posttest between test ($n = 49$) and comparison groups ($n = 51$).

	Means (SD)		<i>t</i> value	<i>p</i> -value	95% CI
	Test	Comparison			
Professional Knowledge	4.40(0.34)	4.45(0.32)	-0.64	.524	(-0.20,0.10)
Nursing Process	4.50(0.34)	4.39(0.35)	1.24	.216	(-0.06,0.25)
Patient Safety	4.61(0.28)	4.39(0.46)	2.73	.008	(0.06,0.39)
Communication	4.47(0.23)	4.01(0.39)	6.30	.000	(0.29,0.56)
Attitude of Reflection	4.47(0.33)	4.12(0.37)	3.65	.000	(0.13,0.45)
Total score	4.49(0.23)	4.30(0.28)	3.21	.002	(0.07,0.30)

Note: CI = confidence interval.

Table 5
Effects of SBL on posttest after control for participant's age.

Competence	Posttest Mean (SD)	Effects of intervention after controlling pretest			Test of Normality
		Mean Square	F	<i>p</i> -value	<i>p</i> -value
Professional knowledge					
Test	4.40(0.34)	0.12	0.11	.745	
Comparison	4.45(0.32)				
Intervention		0.07	.60	.442	.000
Nursing process					
Test	4.50(0.34)	0.01	0.11	.747	
Comparison	4.38(0.35)				
Intervention		0.33	2.82	.096	.000
Patient safety					
Test	4.61(0.28)	0.11	0.77	.383	
Comparison	4.39(0.45)				
Intervention		1.36	9.70	.002	.000
Communication					
Test	4.47(0.23)	0.02	0.15	.703	
Comparison	4.01(0.38)				
Intervention		5.02	50.36	.000	.000
Attitude of Reflection					
Test	4.47(0.33)	0.14	1.10	.296	
Comparison	4.12(0.37)				
Intervention		2.37	19.05	.000	.000
Total score					
Test	4.49(0.23)	0.03	0.51	.476	
Comparison	4.30(0.28)				
Intervention		0.99	14.78	.000	.007

verifies the review of relevant literature showing that SBL is a valid teaching strategy/learning strategy that increases participants' conception of improving student competences (Bliss and Aitken, 2018; Boling and Hardin-Pierce, 2016; Curl et al., 2016; Kaddoura et al., 2016; Kimhi et al., 2016). In the comparison group, two of the five student competences, namely professional knowledge and nursing process, showed significant differences between pretest and posttest, indicating that participants in the comparison group were also aware of improvement in knowledge after receiving a typical course. In Hung et al. (2016) SBLES, subscale “professional knowledge” comprised seven items covering pathophysiology, side effect of medications, information in the chart, laboratory finding, and so forth. Boling and Hardin-Pierce (2016) conducted a 17-studies integrative review and found that all 17 studies demonstrated an improvement in knowledge,

Table 6
Comparison of practicum grade between test ($n = 27$) and comparison groups ($n = 27$).

	Mean	SD	F	p-value
Professional Knowledge				
Test group	6.46	0.60	0.80	0.375
Comparison group	6.29	0.56		
Technical skills				
Test group	18.01	0.98	0.38	0.539
Comparison group	17.39	1.35		
Critical thinking				
Test group	12.51	0.51	1.27	0.214
Comparison group	12.15	1.17		
Communication				
Test group	8.38	0.36	2.77	0.102
Comparison group	8.06	0.64		
Nursing Process				
Test group	16.01	0.77	2.67	0.131
Comparison group	15.57	1.52		
Total Grade				
Test group	61.38	2.70	1.01	0.321
Comparison group	58.06	3.66		

Note: Practicum grade of each competence: professional knowledge (8 points), technical skills (22 points), nursing process (20 points), communication (10 points), and critical thinking (15 points).

and scores in the intervention groups were consistently higher than those in the control group who did not participate in the SBL. Our findings are inconsistent with Boling and Hardin-Pierce's study. One explanation is that SBL is a teaching strategy that actively "made them think" and helped students to synthesize and apply knowledge and then gain new knowledge (Mager and Campbell, 2013). Conversely, in didactic lectures the focus is to explain the textbook through the teacher, so that students can passively acquire knowledge. Either SBL or a typical course could improve students' professional knowledge and the results are acceptable because the students in both test and comparison groups all received 36 h teaching.

The nursing process includes several stages, such as assessment, nursing intervention, skill implementation, and evaluation, and is a process of problem-solving. In this study, the students in the test group rated significant progression in this subscale. This finding is consistent with the previous studies where SBL has been reported to have a positive effect on participants' confidence in their knowledge and skills (Ozekcin et al., 2015). Bliss and Aitken (2018) conducted an exploratory qualitative study and found registered nurses perceived that SBL enhanced their knowledge and assessment ability in recognizing the deteriorating patient. The higher score of perception of nursing process seems to be often accompanied by similarly elevated knowledge scores. In this study, the students in the comparison group also perceived that they had made positive progression on the nursing process.

This study reveals significant improvements on three competences: patient safety, communication, and attitude of reflection in response to SBL as compared to the comparison group. Numerous other studies have supported this finding (Foronda et al., 2013; Norman, 2012). This finding also reflects Kolb (1984) ELT whereby the learner learns from experiences to amend new action, rather than relying on cognitive knowledge. The circle of Kolb (1984) ELT contributes to the learners' "soft" competences. Moreover, although students in the comparison group perceived positive progression on professional knowledge and nursing process, the findings showed there were significant differences in patient safety, communication, and attitude of reflection between the test and comparison groups. This indicated that students in the test group perceived more comprehensive progression than those in the comparison group (Table 5). SBL not only affects "soft" competences, but also promotes cognitive ability.

The results in Table 5 showed that posttest scores in five student competences were not affected by pretest scores and age difference,

indicating that the greater posttest scores in the test groups were related to the SBL. The findings in Tables 3–5 were consistent and reveal the participants might perceive that SBL increased their competences and the improvement may be essentially related to SBL. This is consistent with previous studies that reported SBL was an effective method for students to improve their competences (Mager and Campbell, 2013; Moreland et al., 2012). In addition, it was important to note that despite a previous study which found that greater "age" was a predictor of higher competence for prelicensure nursing students after experiencing SBL (Shinnick and Woo, 2013), there was no influence of age difference in our results. This is important because it indicates that SBL is appropriate for the diverse array of ages in nursing education. In this study, we used the advanced analysis method to make up for the shortcomings of previous studies and further confirmed the effects of SBL on student perception of student competences.

The other study purpose of this study was to explore the effect of SBL on student performance in clinical settings. The results revealed that the participants in the test group did not show improved performance when compared to those in the comparison group; this finding is consistent with the studies of Griggs (2003) and Hayden et al. (2014). Griggs (2003) randomly assigned 27 students into test and comparison groups and used a multiple-choice examination and a 40-item Likert scale survey to examine student nursing knowledge, anxiety, decision-making ability, and competence in working with patients with specific diagnoses. The results indicated that simulation training did not exert an effect on student knowledge or clinical performance. Although our study findings are consistent with Griggs's study, it is important to note one particular difference between the studies. Griggs's results were derived from student perspectives, while the results of our current study were objectively scored by clinical preceptors. Moreover, the results also provide support to the study by Feingold et al. (2004) that most of the students disagreed that SBL could transfer learning to real clinical settings, and our study confirmed the result of students' perspective. One explanation is considered in discussing the results. The scenarios that lecturers provide for students in a course are limited and the students are always able to experience various situations in their practicum. This explanation might support Knight (1998) claim that simulation experiences in a laboratory would never replace clinical experiences with reality.

4.1. Implementation in nursing

Investigations of the effect of SBL on students' perception of nursing competence and clinical performance are important in their contribution toward school education. This study uncovered new information that SBL is considered as an effective and attractive teaching strategy that makes students' learning interesting. This finding could guide school instructors to consider multiple strategies to support the students' learning motivation and accumulation of experiences. Moreover, the information from SBL appears to be directing the school instructors to deliberate about the content of scenarios relating to soft skills, rather than cognitive knowledge. It also requires them to select diverse scenarios from numerous clinical situations because students achieved competency through encountering real world situations similar to the one in the simulation. Such information is often lacking in nursing education and research, yet an evaluation of students' perceptions is paramount so that instructors can understand the effects surrounding the optimal delivery of teaching strategies. The outcome of this study provided objective data to determine the effect of SBL on students' perceptions of their competences in a nursing school. Importantly, this study provides a tangible framework that allows other nursing schools to follow similar approaches to curriculum strategies.

4.2. Limitations

Some methodological limitations must be considered in this study.

First, this study is limited in generalizability because of its sampling, sample size, and practicum settings. We simply designated day and evening division attendees into test and comparison groups in consideration of teaching consistency. Next, according to calculations conducted using G*Power software, each group consisted of 50 participants and qualified the statistic power to explore the study purpose 1 and 2 rather than purpose 3. It is necessary to extend the study period and obtain data from future practicums. In addition, all the hospitals providing the practicum settings in our study had the same characteristics of a hospital classification. Although this design effectively reduces the variation from environmental factors, it limited the generalizability to non-government, not-for-profit, accredited acute care, and teaching hospitals.

According to Kolb's ELT, learners learn from reflection on previous experiences and, in this study, most of the participants learned from observing other's experiences. This design is congruent with the character of vocational universities in Taiwan in that a class consists of approximately fifty students. Finally, the practicum evaluation form that we used in this study has no explicit validity and reliability determined. No instrument has yet been found to evaluate student performance in clinical settings after experiencing SBL and it is necessary to develop such a related instrument in the future.

5. Conclusions

The effects of SBL on students' perception of competences in an advanced acute care adult course have been further explored in this study. The findings show that both SBL and typical lecture could improve students' knowledge and abilities within the nursing process. Moreover, the students in the test group perceived greater progression of "soft" competences than those in the comparison group. In addition, there was no difference noted in clinical performance between the test and comparison groups, indicating the effect of learning did not extend to clinical practice. The findings showed that SBL is seen as an attractive teaching strategy for students to learn as part of the curriculum and that the effects of SBL on clinical practice need further examination.

Disclaimer information

The authors declare no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding sources

This work was supported by the Ministry of Science and Technology, R.O.C. (Grant Number: MOST104-2511-S-255-010).

Ethical approval details (if applicable)

The study was reviewed and approved by the institutional review board of the study hospital and university (approval number: 103–2270B).

Declaration of competing interest

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Acknowledgment

This work was supported by the Ministry of Science and Technology, R.O.C. (Grant Number: MOST104-2511-S-255-010). The authors want to thank Ms. Hsiu-Chen Liu who is the instructor responsible for the advanced acute care adult course and lodged scenarios in this course for this study.

References

- Bliss, M., Aitken, L.M., 2018. Does simulation enhance nurses' ability to assess deteriorating patients? *Nurs. Educ. Pract.* 28, 20–26. <https://doi.org/10.1016/j.nepr.2017.09.009>.
- Boling, B., Hardin-Pierce, M., 2016. The effect of high-fidelity simulation on knowledge and confidence in critical care training: an integrative review. *Nurs. Educ. Pract.* 16, 287–293. <https://doi.org/10.1016/j.nepr.2015.10.004>.
- Canales, M.K., French, H., 2003. Experiential learning as service for others. *Assoc. Oper. Room Nurs.* 77, 1232–1239. [https://doi.org/10.1016/S0001-2092\(06\)60984-8](https://doi.org/10.1016/S0001-2092(06)60984-8).
- Cooper, H.M., Hedges, L.V., 2009. *The Handbook of Research Synthesis*. Russell Sage Foundation, New York.
- Curl, E.D., Smith, S., Chisholm, L.A., McGee, L.A., Das, K., 2016. Effectiveness of integrated simulation and clinical experiences compared to traditional clinical experiences for nursing students. *Nurs. Educ. Perspect.* 37, 72–77. <https://doi.org/10.5480/15-1647>.
- Faul, F., Erdfelder, E., Buchner, A., Lang, A.G., 2009. Statistical power analysis using G*Power 3.1: tests for correlation and regression analyses. *Behav. Res. Methods* 41, 1149–1160.
- Feingold, C.E., Calaluce, M., Kallen, M.A., 2004. Computerized patient model and simulated clinical experiences: evaluation with baccalaureate nursing students. *J. Nurs. Educ.* 43, 156–163. <https://doi.org/10.3928/01484834-20040401-03>.
- Flood, L.S., Higbie, J., 2016. A comparative assessment of nursing students' cognitive knowledge of blood transfusion using lecture and simulation. *Nurse Educ. Pract.* 16, 8–13. <https://doi.org/10.1016/j.nepr.2015.05.008>.
- Foronda, C., Liu, S., Bauman, E.B., 2013. Evaluation of simulation in undergraduate nurse education: an integrative review. *Clin. Simul. Nurs.* 9, e409–e416. <https://doi.org/10.1016/j.ecns.2012.11.003>.
- Griggs, R.R., 2003. *The Effects of the Use of a Human Patient Simulator on the Acquisition of Nursing Knowledge in Undergraduate Nursing Students at a University in Illinois*. PhD Thesis. Southern Illinois University, Carbondale, IL.
- Hayden, J.K., Smiley, R.A., Alexander, M., Kardong-Edgren, S., Jeffries, P.R., 2014. The NCSBN national simulation study: a longitudinal, randomized, controlled study replacing clinical hours with simulation in prelicensure nursing education. *J. Nurs. Regul.* 5 (Suppl. 1). [https://doi.org/10.1016/S2155-8256\(15\)30062-4](https://doi.org/10.1016/S2155-8256(15)30062-4). S3-S40.
- Helmreich, R.L., Foushee, H.C., 1993. Why crew resource management? Empirical and theoretical bases of human factors training in aviation. In: Wiener, E.L., Kanki, B.G., Helmreich, R.L. (Eds.), *Cockpit Resource Management*. Academic Press, San Diego, CA, US, pp. 3–45.
- Hung, C.C., Liu, H.C., Lin, C.C., Lee, B.O., 2016. Development and validation of the simulation-based learning evaluation scale. *Nurse Educ. Today* 40, 72–77. <https://doi.org/10.1016/j.nedt.2016.02.016>.
- IBM, 2015. *IBM SPSS Statistics For Windows, Version 23.0*. IBM Corp, Armonk, NY.
- Kaddoura, M., Vandyke, O., Smallwood, C., Gonzalez, K.M., 2016. Perceived benefits and challenges of repeated exposure to high fidelity simulation experiences of first degree accelerated bachelor nursing students. *Nurse Educ. Today* 36, 298–303. <https://doi.org/10.1016/j.nedt.2015.07.014>.
- Kimhi, E., Reishtein, J.L., Cohen, M., Friger, M., Hurvitz, N., Avraham, R., 2016. Impact of simulation and clinical experience on self-efficacy in nursing students: intervention study. *Nurse Educ.* 41, E1–E4. <https://doi.org/10.1097/NNE.0000000000000194>.
- Knight, C.M., 1998. Evaluating a skills centre: the acquisition of psychomotor skills in nursing: a review of the literature. *Nurse Educ. Today* 18, 441–447. [https://doi.org/10.1016/S0260-6917\(98\)80169-X](https://doi.org/10.1016/S0260-6917(98)80169-X).
- Kolb, D.A., 1984. *Experiential Learning: Experience as the Source of Learning and Development*. Prentice-Hall, Englewood Cliffs, NJ.
- Leonard, B., Shuhaibar, E., Chen, R., 2010. Nursing student perceptions of intraprofessional team education using high-fidelity simulation. *J. Nurs. Educ.* 49, 628–631. <https://doi.org/10.3928/01484834-20100730-06>.
- Mager, D.R., Campbell, S.H., 2013. Home care simulation for student nurses: medication management in the home. *Nurse Educ. Today* 3, 1416–1421. <https://doi.org/10.1016/j.nedt.2012.11.007>.
- Moreland, S.S., Lemieux, M.L., Myers, A., 2012. End-of-life care and the use of simulation in a baccalaureate nursing program. *Int. J. Nurs. Educ. Scholarsh.* 9, 1–13. <https://doi.org/10.1515/1548-923X.2405>.
- National Council State Board of Nursing, 2005. *Clinical instruction in prelicensure nursing programs*. Position Paper. Retrieved December 2, 2013, from: https://www.ncsbn.org/Final_Clinical_Instr_Pre_Nsg_programs.pdf.
- Norman, J., 2012. Systematic review of the literature on simulation in nursing education. *The ABNF J.* 23, 24–28.
- Ozekcin, L.R., Tuite, P., Willner, K., Hrvanek, M., 2015. Simulation education: early identification of patient physiologic deterioration by acute care nurses. *Clin. Nurse Spec.* 29, 166–173.
- Sapiano, A.B., Sammut, R., Trapani, J., 2018. The effectiveness of virtual simulation in improving student nurses' knowledge and performance during patient deterioration: a pre and post test design. *Nurse Educ. Today* 62, 128–133. <https://doi.org/10.1016/j.nedt.2017.12.025>.
- Shinnick, M.A., Woo, M.A., 2013. The effect of human patient simulation on critical thinking and its predictors in prelicensure nursing students. *Nurs. Educ. Today* 33, 1062–1067. <https://doi.org/10.1016/j.nedt.2012.04.004>.
- Weaver, A., 2011. High-fidelity patient simulation in nursing education: an integrative review. *Nurs. Educ. Perspect.* 32, 37–40.