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Research Paper

The influence of heart failure high-fidelity simulation education based on NLN Jeffries simulation framework in the prelicensure nursing program: A quasi-experimental study

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ABSTRACT

Objectives: To examine the influence of heart failure high-fidelity simulation education based on the National League for Nursing (NLN) Jeffries Simulation Framework in prelicensure nursing education.
Methods: A heart failure high-fidelity simulation (HFHFS) education pilot project was carried out at Carrington College Sacramento. Twenty-three students participated in the study. This study used a quasi-experimental design. Students' Self-Efficacy, Satisfaction, and Knowledge in Heart Failure Clinical Knowledge were measured pre- and post-HFHFS education.
Results: The results of the high-fidelity simulation education for heart failure showed that students achieved a mean score of 45.39 ($SD = 7.88$) in self-efficacy, 18.70 ($SD = 3.38$) in satisfaction, and 64.09 ($SD = 10.86$) in knowledge after the intervention. The paired-sample t-test significantly improved between the pre- and post-intervention scores ($P < 0.001$). The students highly rated self-efficacy, student satisfaction, and knowledge because of the positive impact on the teaching effectiveness of simulation design (i.e., objectives, problem-solving, student support, fidelity, debriefing) activity that included the application of quality safety education for nurses (QSEN) three competencies safety, patient-centered care, and teamwork and collaboration during nursing care for patients with acute heart failure. The teaching effectiveness of the heart failure high-fidelity simulation education is closely correlated with student satisfaction, self-efficacy, and improvement of participant knowledge in clinical nursing skills performance and critical thinking.
Conclusion: A heart failure high-fidelity simulation education established upon the National League for Nursing (NLN) Jeffries framework enhanced student knowledge, satisfaction, self-efficacy, application of safety, patient-centered care, and teamwork and collaboration. Nurse educators should consider simulation planning to include the five simulation design characteristics, i.e., objectives, problem-solving, student support, fidelity, and debriefing, while integrating safety, patient-centered care, and teamwork and collaboration to bring about education effectiveness.

What is known?

- During the COVID-19 pandemic, many nursing programs experienced difficulties in clinical placement.
- Nursing programs and students reported that they felt distressed when transitioning to the clinical environment and did not have the proper training to meet care demands.
- If nursing students are not adequately prepared and exposed to the clinical environment, the dropout rate will rise, and professional development will decline.
- An ongoing problem in clinical education is the gap between what students are taught didactically and what they learned in the clinical setting.

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What is new?

- Clinical education and nursing competence are components of the nursing curriculum and practice. The high-fidelity simulation education program established upon the National League for Nursing (NLN) Jeffries Simulation Framework theoretical framework proved effective in strengthening nursing students' comprehensive competence.
- Students acquire knowledge, skills, and the ability to provide optimum care by engaging in practical learning experiences and applying theories.

1. Introduction

The emergence of the coronavirus (COVID-19) pandemic changed educational strategies as clinical sites were no longer accessible for clinical experiential learning. Nursing programs had to restore and modify clinical scenarios by reviving game plans and altering instructions, assessment methods, and learning in nursing school [1]. It produced unprecedented times for nursing pedagogy as it necessitated clever teaching strategies to enhance students' clinical instruction, making sure that the required educational outcomes and professional skills were attained. The traditional clinical rotations and didactic experiences were replaced by virtual or remote simulated instructional experiences using telehealth, technology-amplified storyboard techniques, and screen-based simulation for nursing students and faculty. Besides, nursing programs were not prepared to transition to remote learning, which challenges nursing curricula change and education [2]. Financial setbacks, clinical learning disruption, students, faculty, and staff reactions to the loss, stress, anxiety, and keeping up with accreditation standards were some additional challenges nursing schools faced [3].

The nursing practice focuses on providing competent care to the patient in the clinical setting where direct supervision is important. In the existing circumstance caused by the COVID-19 pandemic, the school of nursing experienced a gap in linking theoretical knowledge and clinical experience. However, this gap should be closed because students fear transitioning from preclinical to clinical settings as nurses. Hence, providing educational training in basic nursing skills during the COVID-19 pandemic and post-COVID-19 using high-fidelity simulation (HFS) to train students who will become qualified nurses providing care to the patient will involve ongoing demonstration in knowledge, skills, and ability (KSA) with an emphasis in quality safety education for nurses (QSEN) competencies such as safety, patient-centered care, and teamwork and collaboration is vital [4,5].

HFS refers to a teaching-learning method that uses extensive computerized patient simulators to present real clinical scenarios and characteristic signs or symptoms of an illness. HFS has been widely adopted in nursing education [6]. In addition to being low-risk and lacking human endangerment, HFS can play a significant role in teaching and assessing students' professional competence, including critical thinking, clinical reasoning, effective communication, patient-centered care, safety, and teamwork and collaboration, before working as a competent nurse. According to a meta-analysis and systematic review that were conducted, it revealed that HFS has a high effect on education while helping student nurses enhance professional skills, knowledge gain, self-confidence, learning satisfaction, and prepare skills in clinical nursing such as communication and clinical judgment and critical thinking [7,8]. A quasi-experimental study design is an important guarantee of the influence of HFS education [9].

Currently, it is confirmed that verification of teaching objectives, desired outcomes, and feedback are effective predictors for influencing simulation education [10]. However, studies that have confirmed the effectiveness of HFS education methodology and heart failure HFS education quasi-experimental pilot study design have rarely been addressed. In addition, the comprehensiveness of the questionnaire scale on heart failure knowledge test, self-efficacy, and student satisfaction instruments plus heart failure HFS scenario contents used in prior studies in evaluating the influence of heart failure HFS in caring for acute heart failure patients was determined, validated by expert panel review and individual interviews as reliable.

The use of HFS in nursing education is ubiquitous. It is essential to incorporate andragogy with a sound theoretical framework to guide simulation-based education to promote safety, psychological fidelity, and student learning outcomes [10,11]. The National League for Nursing (NLN) Jeffries Simulation Framework construct component was originally developed by Dr. Jeffries in 2005 and used to guide educational practices [12–15]. Based on the questionnaire scale, heart failure scenario, and 2005 NLN Jeffries Simulation Framework (Fig. 1), this study examined the influence of heart failure HFS education based on the NLN Jeffries Simulation framework in prelicensure nursing education.

2. Participants and methods

2.1. Subjects

Twenty-three students (18–54 years in age) majoring in nursing science were selected from one course during the final term of the program at a traditional Associate Degree in Nursing program at Carrington College Sacramento, of which five were male, and eighteen were female.

2.2. Methods

The subjects had formerly successfully completed prerequisite classes toward the Medical Surgical III course. Pre-licensure nursing students in their final term, taking an Advanced Medical Surgical course and attending Medical-Surgical clinical rotation, were enrolled in a training course used in this quality improvement pilot project. Due to COVID-19 pandemic restrictions with social

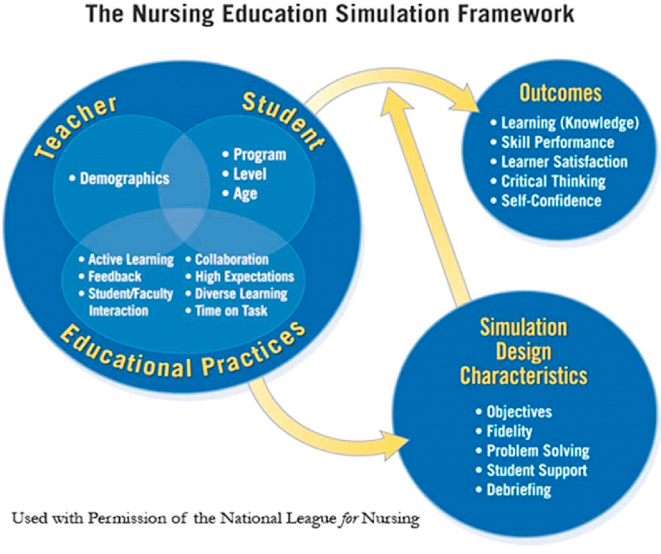

Fig. 1. The National League for Nursing Jeffries framework.

distancing, the small sample size of twenty-three students was the focus for this pilot study test in evaluating the impact of the intervention on participants' self-efficacy, student satisfaction, and knowledge in the care of acute heart failure patients in the form of HFS using patient simulators. A larger sample size will be used in the post-COVID-19 for comparison. The specified training methods were as follows:

2.2.1. The training program determination and case scenario design

Three to four weeks after the resumption of the summer term during COVID-19 and in the middle of the didactic and clinical rotation of the nursing students, a neutral faculty member not involved in the study made an announcement to the nursing students. The announcement involved face-to-face meetings of the project manager with the Advanced Medical Surgical III course students in their didactic classrooms. Before the simulation activity, the learning objective was discussed with students. The student learned and applied the integration of QSEN competencies such as safety, patient-centered care, teamwork, and collaboration during nursing care for patients with acute heart failure. The instructor regulated the simulation activity and achieved the objectives of the QSEN competencies. In contrast, the simulation assistant tracked students' success in the action using the Skills Checklist. The checklist evaluated the expected skills attained during debriefing in the students but was not utilized as part of their grades in the course.

The selection of approximately 23 participants was the convenience sample that took part in the study. Every nursing student in their final term and in the pre-licensure nursing program who was enrolled in an Advanced Medical Surgical III course in the Summer during the COVID-19 pandemic was offered to partake in the study. The students who had been involved in simulation as part of the curriculum during their undergraduate program were the ones who participated in the study. One simulation case scenario was utilized in this study. The case depicted a clinical situation in which a 75-year-old female with an acute decompensated HF was presented. The student learned and applied integration of QSEN competencies safety, patient-centered care, and teamwork and collaboration during patient care.

2.2.2. Presentation of cases, objectives, and pre-training preparation

The simulator faculty experienced the background operation and maintenance of HFS equipment, including the patient simulator. The instructor entered the information on heart failure HFS case scenario content into the computer to design a series of disease conditions of the simulator patient based on the objective of the changes of disease condition of the acute heart failure patient simulator and provision of care based on safety, patient-centered care, and teamwork and collaboration. In preparation for a practical HFS experience for the students, the instructor prepared the students by allocating assignments to the patients' simulator, provided orientation on the use of the equipment one week ahead of time, and videotaped every session to be used as a reference. The instructor achieved the objective by ensuring safety, teamwork collaboration, and patient-centered care were demonstrated by the students.

2.2.3. Phases of training

The heart failure HFS selection for this study focused on patients with acute heart failure clinical situations, and the scenarios focused on basic nursing responses. The scenario was used with the permission of the California Simulation Alliance. The developers of scenarios relinquished all their rights to the intellectual property to Dr. Waxman and had authorized personnel to release the forms. The scenario includes a debriefing session, was revised, pilot tested, and revised again to include safety, patient-centered care, teamwork, and collaboration. The Heart Failure Knowledge Questionnaire Instrument (HFKQI) from a prior study was congruent with the scenario. This study also provided an additional quantitative evaluation of the impact of the intervention on participants' Self-Efficacy and Student Satisfaction. In a stepwise approach to the heart failure HFS, the nursing students took turns and performed nursing clinical skill training. At the present trend, the disease progressed. If the student applies the correct measures effectively and appropriately, the condition of the patient will be enhanced. For instance, in the case of a patient experiencing dyspnea, the nurse responded, elevated the head of the bed, administered oxygen via a nasal cannula, and followed the physician's order. The nurse critically examined the laboratory results of a patient receiving a diuretic and selected the medication the physician ordered. The student worked as a team and collaborated while maintaining social distance, provided QSEN competencies in patient-centered care, and promoted patient safety. On the other hand, if the student did not have good judgment and provided ineffective care, the patient's condition would decline, eventually leading to death. Every development comprises five nursing processes: assessment, diagnosis, planning, intervention, and evaluation.

2.2.4. Debriefing

The guided oral debriefing session was not individualized but in groups. The students evaluated and reflected on what part of the nursing process went well and what did not go well. The collaborative debriefing inspired the students' participation in class, such as discussing the scenario and sharing ideas for improvement.

2.3. Tool evaluation

The Heart Failure Clinical Questionnaire Instrument (HFCQI) was used to measure students' knowledge of caring for patients with HF. This instrument was developed to determine whether HFS can promote nursing students' knowledge gained in their final term of the pre-licensure nursing program [16]. The instrument comprised 17 pre-survey and 17 post-survey questionnaires written on a 5-point Likert scale: A = 1, *not at all confident*; B = 2, *slightly confident*; C = 3, *moderately confident*; D = 4, *very confident*; E = 5, *extremely confident*. Before providing summaries of the pre-and post-intervention knowledge scores, both knowledge scores were evaluated for inter-item reliability using Cronbach's α coefficient. The α values for the pre- and post-test knowledge surveys were 0.948 and 0.964, respectively. The HFCQI pre-test and post-test were developed to focus on the management of the signs and symptoms of heart failure patients. Every test version of the HFCQI was not similar but parallel to the other one, and the name of heart failure was not mentioned so that the students would be blindfolded to the simulation topic. The focus of the intervention question was on nursing desired intervention for associated common heart failure issues. The tests were designed in Kolb Learning Style Inventory. The contents of the heart failure clinical knowledge tests were validated by three expert nurses experienced in the care of heart failure patients and a cardiologist practicing in a heart failure specialty clinic. All the panel experts agreed 100% on the content and the version of the heart failure clinical knowledge test [16]. Shinnick gave permission to this writer to modify the instrument and use it based on the project objective. In addition, for the Self-Efficacy for Nursing Skills Evaluation Tool in the form of a Likert-type questionnaire, which evaluates students' confidence or self-efficacy in the care of patients with pulmonary disease, Shinnick edited the original per the original author's permission. Self-

efficacy has items that prioritize doctor's orders in managing pulmonary post-op complications and taking patient vital signs. The Knowledge Questionnaires pre-test and post-test point time participants assessment also took this test. The Cronbach's α coefficient of this instrument is 0.87 [16].

In a prior study, Self-efficacy has been shown to influence knowledge and is believed to have been increased in human patient simulator activity [16]. Our study shows a significant increase following the intervention. In addition, this study evaluated student satisfaction using the Heart Failure High-Fidelity Simulation Survey Likert scale developed by Shinnick [16] to express satisfaction level participating in the heart failure HFS activity contributing to positive impact in knowledge increase in caring for acute heart failure simulator patient. Results show that students were satisfied with the intervention.

2.4. Data collection

The students' demographics collected included age, gender, race/ethnicity, and students' preferred learning methods. The demographic data and pre-survey Likert scale survey questionnaires were completed at Time 1 during a simulation class 15 min before the intervention by a single group of approximately 23 participants. Once the debriefing sessions were completed, a post-survey questionnaire was administered at Time 2 on the same day on Survey Monkey for 10 min, following the dates assigned to the groups.

2.5. Data analysis

A paired-sample *t*-test was used to compare the mean differences in knowledge scores between pre- and post-survey questionnaires related to the care of patients with HF. The primary objective was to assess the impact of participating in an HFHFS on participants' knowledge of caring for patients with acute HF. All analyses were conducted using IBM SPSS Statistics for Windows (Version 28.0. Armonk, NY: IBM Corp).

Descriptive statistics were utilized to characterize the sample and examine the assumptions necessary for parametric testing of the dependent variable data at Time 1 and Time 2. The mean and standard deviation of each item were calculated. To achieve a confidence level of 95%, the significance level was set at $P = 0.05$.

3. Results

3.1. Participants' characteristics

A total of 23 students participated in the study, as presented in Table 1. The age range of the students varied from 18 to 54 years old, with the most frequent age group being 25–34 years ($n = 10$). Most of the participants identified their ethnicity as Asian or Pacific Islander ($n = 9$) and White ($n = 9$), followed by African American ($n = 2$), Hispanic or Latino ($n = 2$), and Filipino ($n = 1$). Regarding gender distribution, most of the participants were female ($n = 18$, 78.3%). In terms of preferred learning methods, 19 students (82.6%) indicated a preference for "hands-on learning," while the remaining 4 participants expressed a preference for other learning methods.

Table 1
Participant characteristics ($n = 23$).

Variable	*n* (%)
Age (years)	
18 to 24	2 (8.7)
25 to 34	10 (43.5)
35 to 44	7 (30.4)
45 to 54	4 (17.4)
Gender	
Female	18 (78.3)
Male	5 (21.7)
Ethnicity	
Asian or Pacific Islander	9 (39.1)
Black or African American	2 (8.7)
Filipino	1 (4.3)
Hispanic or Latino	2 (8.7)
White/Caucasian	9 (39.1)
Preferred Learning Method	
Audio visual learning	1 (4.3)
Experimental (laboratory skills)	2 (8.7)
Hands on learning	19 (82.6)
Working in groups	1 (4.3)

3.2. Statistics summary of pre- and post-intervention scores

Table 2 summarizes the statistics of pre- and post-intervention scores for self-efficacy, student satisfaction, and knowledge.

A significant increase in self-efficacy was observed following the intervention. The mean score for self-efficacy at the post-intervention stage (45.39 ± 7.88) was significantly higher than the pre-intervention score (38.91 ± 8.35) ($t = 5.54$, $P < 0.001$), indicating a positive impact of the intervention on participants' self-efficacy. Similarly, student satisfaction showed improvement because of the intervention. The mean score for student satisfaction at the post-intervention stage (18.70 ± 3.38) was significantly higher than the pre-intervention score (15.57 ± 3.38) ($t = 6.26$, $P < 0.001$), indicating an increase in student satisfaction following the intervention. The intervention also had a significant impact on participants' knowledge. At the pre-intervention stage, participants had a mean knowledge score of 54.48 ($SD = 11.19$). After the intervention, the mean knowledge score increased to 64.09 ($SD = 10.86$). The paired-sample *t*-test revealed a significant difference between the pre- and post-intervention scores ($t = 6.44$, $P < 0.001$), demonstrating a substantial improvement in participants' knowledge because of the intervention.

These findings highlight the positive impact of the intervention on participants' self-efficacy, student satisfaction, and knowledge. The results provide support for the effectiveness of the intervention in achieving desired outcomes, particularly in areas related to safety, patient-centered care, teamwork, and collaboration. To assess the effectiveness of teaching and knowledge enhancement in the Carrington College associate degree program, this researcher compared the National Council Licensure Examination test annual aggregate scores for 2020/2021 and 2021/2022. The analysis revealed that in 2020/2021, approximately 63 students took the examination, and the overall score during that period was 73.02%. Similarly, in 2021/2022, a total of 74 students took the examination, achieving an aggregate score of 83.7%. These results indicate a correlation between effective teaching methods and increased knowledge (rn.ca.gov) [17]. It is worth noting that posit HFS were found to have the greatest effect on psychomotor skills for various types of nurses, including nurse practitioners. Furthermore, high-fidelity simulations consistently led to knowledge gains in skill-related activities. Additionally, the California Board of Nursing has recommended that up to 25% of learning should take place in the laboratory setting.

4. Discussion

4.1. Student evaluation satisfaction of the design of heart failure high-fidelity quasi-experimental pilot study

Outcome satisfaction measures can be assessed by five domains:

Table 2
Statistics summary of pre- and post- intervention scores.

Variable		*Mean* ± *SD*	Range	Scale	*t*	*P*
Self-Efficacy	Pre	38.91 ± 8.35	20–53	12–60	5.54	<0.001
	Post	45.39 ± 7.88	29–60			
Student Satisfaction	Pre	15.57 ± 3.38	8–21	5–25	6.26	<0.001
	Post	18.70 ± 3.28	14–25			
Knowledge	Pre	54.48 ± 11.19	33–74	17–85	6.44	<0.001
	Post	64.09 ± 10.86	43–85			

knowledge acquisition from performing nursing skills is measured accurately, learner satisfaction, critical thinking, debriefing, and self-confidence in educational practices. In this study, the post-intervention scores in all dimensions surpassed pre-intervention scores, indicating reasonable and rational learning experiences. The mean score for student satisfaction at the post-intervention stage was 18.70 ± 3.38 points (Table 2). Notably, the satisfaction score in this study was significantly higher compared to other reports [18]. A scoping review conducted in the United States of America (U.S.A) examined the impact of changes in clinical training due to the COVID-19 pandemic, wherein structured steps in simulation learning were introduced in pre-licensing nursing programs. This shift contributed to high satisfaction and positive learning outcomes in nursing students. The structured steps in simulation sessions included recommended reading, pre and post-simulation quizzes, clinical interactive scenarios, and debriefing sessions. Role-playing exercises enhanced communication abilities and allowed for the reproduction of traditional care through flipped clinical practice practical activities. Proposed scholarly journals promoted reflection and knowledge for virtual clinical practices. Following the simulation sessions, interactive and engaging debriefing meetings helped students analyze case management while learning from the experience. It was observed that learning predominantly occurred during positive debriefing and reflection moments. Nursing education is a collaborative effort to ensure the best outcomes for nursing students and patients [19,20]. In interviews and at the conclusion of the program, nursing students expressed that HFS learning methodology greatly aided in their ongoing clinical experiential learning [1].

4.2. Evaluation of student self-efficacy in a heart failure high-fidelity quasi-experimental pilot study

Permission to use the NLN Jeffries Simulation Framework (2007) in Fig. 1 in this study is granted by Elsevier. The NLN Jeffries Simulation Framework is a theoretical framework that, in recent years, has continued to provide empirical support in the field of nursing educational practices. In recent years, it has been recommended that Jeffries' framework be used to guide educational design, its implementation of progressive research, evaluation of patient simulators scenarios, and outcomes measures [12,13]. Self-efficacy and satisfaction are factors in the outcome measures in Jeffries educational framework used by students to evaluate HFS in a comprehensive way [10,12,13,18]. In this study, the self-efficacy post-intervention score for nursing students was 45.39 ± 7.88, significantly higher than the pre-intervention score, indicating a positive impact of the intervention on participants' self-efficacy. Furthermore, during the COVID-19 pandemic, the teaching enabled the application of concepts reviewed from nursing theories in simulated scenarios or boosted learning in an interactive clinical educative environment. Interactions between a student-professor and fellow student-student enhance information in the nursing process, competencies, clinical analysis, interchange in opinion, feedback, reinforcement in clinical concepts, and encouragement of ongoing discussions. HFS played a crucial role in shaping students' attitudes, including resilience, gratitude, and patient confidence, while embracing advocacy for patient-centered care, safety, teamwork, and collaboration. However, students faced challenges managing multiple technological devices to access website materials or videos [1].

4.3. Student evaluation of knowledge heart failure high-fidelity quasi-experimental pilot study

According to the Society for Healthcare Simulation, HFS is defined as the simulation that brings realistic experiences involving interactions to the learner. HFS enhances knowledge, facilitates individualized clinical experiential decision-making, and promotes student skills and critical thinking in the nursing care of patients with a health problem, all within a risk-free environment [1,9,10,12]. In this study, the mean knowledge score significantly increased to 64.09 ($SD = 10.86$) after participating in the heart failure HFS focused on the care of acute heart failure patients. The paired *t*-test revealed a substantial difference between pre- and post-intervention scores ($P < 0.001$).

The findings suggest that the HFS effectively enhanced students' knowledge acquisition in the context of acute heart failure care. By immersing students in a realistic and risk-free environment, the simulation provided them with valuable opportunities to apply theoretical knowledge, make clinical decisions, and refine their critical thinking skills. The interactive nature of the simulation allowed students to engage in hands-on learning experiences, enabling them to develop a deeper understanding of the complexities and nuances involved in caring for patients with acute heart failure.

Overall, the study supports the use of HFS as an effective educational strategy for improving students' knowledge and skills in the field of nursing. By providing a realistic and immersive learning environment, HFS can bridge the gap between theoretical knowledge and practical application, preparing students for real-world clinical challenges and enhancing their overall competence in patient care.

5. Limitations

The sample size of the study was small. Using a small sample to conduct a pre-and post-education simulation study can introduce several limitations that need to be considered. First and foremost, the sample size may reduce the statistical power, making it difficult to detect meaningful effects or draw robust conclusions about the educational effects. With fewer participants, the results may be more susceptible to chance variations, which may not accurately represent the larger population or target group. The small sample size significantly limits the generalizability.

Furthermore, the small sample size may limit the diversity and variability within the sample. Many factors in educational settings affect students' learning, such as prior knowledge, learning styles, and socio-economic backgrounds. With a small sample, these

individual differences may not be adequately represented, which may affect the external validity and limit the applicability of the findings to a broader context.

6. Conclusion

The heart failure HFS quasi-experiment study during COVID-19 has effectively cultivated knowledge, skills, ability, and collaboration in nursing students while enhancing self-efficacy, satisfaction, and promotion of knowledge. In this study, students' satisfaction, self-efficacy, and knowledge were evident. The post scores in all dimensions were higher than the pre-intervention scores. HFS has a degree of equivalency with various teaching methodologies while instilling clinical learning ability in pre-licensure nursing education. Hence, nurse educators can choose the most suitable teaching methodology for the attainment of the learning outcome intended for pre-licensure students.

CRediT authorship contribution statement

Tricia Nwokocha: Conceptualization, Methodology, Validation, Formal analysis, Investigation, Data curation, Writing - original draft, Writing - review & editing, Project administration. **Nancy Cowan Pinio:** Conceptualization, Methodology, Validation, Formal analysis, Investigation, Resources, Data curation, Writing - review & editing. **Yan Cao:** Conceptualization, Methodology, Validation, Formal analysis, Investigation, Resources, Data curation, Writing - review & editing, Project administration. Statistical Analysis. **Holly Wei:** Conceptualization, Methodology, Validation, Formal analysis, Investigation, Resources, Data curation, Writing - review & editing, Supervision, Project administration. **Satish Mahajan:** Conceptualization, Methodology, Validation, Formal analysis, Investigation, Resources, Writing - review & editing.

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Ethical approval

The study was approved by the study site Carrington College IRB.

Declaration of competing interest

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

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ijnss.2023.09.019.

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