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Improving Ultrasound Simulation Education: Vascular Access

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Abstract

Background: Throughout the last decade simulation education has become an integral part of healthcare education. Designing simulation training for educational programs takes careful consideration and thought to plan an effective and efficient design. To design an effective simulation and learning experience for students a standardized framework must be used. The Jeffries simulation framework can help design an effective simulation experience. Within the framework the debriefing component is listed as an essential variable of simulation design. Its impact on simulation education outcomes is presented in literature. The current simulation education practice at Marian University lacks a formal debriefing period following simulation testing.

Purpose: The purpose of this project was to add a debriefing component to the current practice of ultrasound simulation education, and determine if students' knowledge, confidence, and satisfaction increased.

Methods: This DNP project used a quality improvement design. Quantitative data was collected with post-test questionnaires and surveys. The data was used to assess for differences in satisfaction, confidence, and knowledge scores between the experimental and control group.

Implementation Plan/Procedure: 24 students were randomly divided in two groups. The control group received the current practice, and the experimental group received the current practice with the addition of a debriefing period based on the PEARLS debriefing model. Following each simulation every student was asked to fill out a post-test survey including a knowledge test and the NLN satisfaction and self-confidence survey.

Implications/Conclusion: A debriefing period enhanced student knowledge ($p = 0.00$) and increase student self-confidence ($p = 0.01$). Debriefing periods should be added as fundamental components of US simulation education. This project shows that students in nurse anesthesia programs would benefit with the addition of a formal debriefing period after simulation testing.

Keywords: ultrasound, simulation, simulation-based, training, education, performance, confidence, confidence level, knowledge, knowledge level, impact, checklists, objectives, pre-brief, prebriefing period, debrief, and debriefing period

Improving Ultrasound Simulation Training: Vascular Access

This project is submitted to the faculty of Marian University Leighton School of Nursing as partial fulfillment of degree requirements for the Doctor of Nursing Practice, Anesthesia track. In order to prepare for clinical rotations as a student registered nurse anesthetist (SRNA), it is imperative to gain experience with the tools used to develop anesthesia skills prior to entering the clinical setting. At Marian University, simulation training is currently used to help aid in the transition from didactic education to clinical reality. A portion of the simulation training involves learning how to operate the ultrasonography (US) machines and equipment. As the Marian University Anesthesia Program continues to develop, it seeks to improve the knowledge and confidence level of students prior to entering the clinical setting. This improvement will involve implementing US simulation training designed with the Jeffries simulation framework and the Promoting Excellence and Reflective Learning in Simulation debriefing framework.

Background

Receiving good US simulation education is important for any anesthesia provider. Anesthesia providers must be able to use the US to perform multiple procedures including establishing arterial or intravenous (IV) access. Establishing IV access is arguably the number one step in providing anesthesia safely for any procedure and sometimes this access needs to be acquired with the aid of US (Bortman et al., 2019). US is also used to deliver regional anesthetics and provides a structural view under the skin with simultaneous needle visualization as well as the visualization of local anesthetic spread (Hauglum et al., 2020). Thus, having the ability to be proficient at using US provides patients with a higher quality of safe care (Hauglum et al., 2020).

Throughout the last decade, traditional educational methods of healthcare apprenticeship in medical training have shifted towards a simulation-based education model (Kalaniti &

Campbell, 2015). Simulation-based training's worth and success in education has been proven throughout recent years. Shields & Gentry (2020) recently demonstrated that simulation training provides more significant improvement in knowledge than web-based learning alone. Eroglu & Coskun (2018) found that students can learn to use US with brief periods of training via simulation-based education. Chen et al. (2017) also displayed that US guided regional anesthesia comprehension and technical skills improve with simulation-based training. Simulation-based training is proficient at closing the gap between didactic education and real time clinical exposure. However, simulation-based training without a proper framework may hinder the participants ability to attain expected outcomes from this experiential learning method (INACSL Standards Committee, 2016).

Jeffries (2005) created a simulation model that guides the development of an effective simulation educational experience. Within this model, debriefing is listed as an essential variable of a successful simulation design. The positive impact the debriefing component has had on the outcomes of simulation education have been presented in literature throughout the last two decades (Adamson, 2015; Issenberg et al., 2005; Jeffries, 2005; Levett-Jones & Lapkins, 2014; Paige et al., 2015).

Problem Statement

The current practice of US simulation training at Marian University does not follow a standardized framework for simulation development. Having a standardized framework to aid in the design and development of simulation will provide students with a better-quality experience (INACSL Standards Committee, 2016). Wiggins et al. (2018) showed that when a blended curriculum of deliberate practice, checklist, simulation, and debriefing are used for US simulation it results in increased knowledge and confidence gain for participants. This led to the following PICO question: In student registered nurse anesthetists, how does ultrasound simulation training for vascular access with a debriefing period, compared with the current practice of ultrasound simulation training for vascular access, affect the satisfaction, confidence, and knowledge of students?

Gap Analysis

The current practice of US simulation education at Marian University lacks an important variable of simulation design. More specifically, US simulation training at Marian University lacks a debriefing period following the simulation experience. Currently students are given a checklist, online videos, and readings to prepare for the simulation experience. Upon entry into the simulation lab, students are tested on their ability to perform assigned techniques. The instructor may go over some of the aspects they did well or could improve upon after the skill has been performed. However, there is no formal debriefing period in which the instructor and student discuss the simulation experience. Thus, implementation of a debriefing period following US simulation training should help improve learning outcomes for students.

Review of Literature

Search Methodology

PubMed, Google Scholar, and the AANA webpage were utilized for the search of applicable literature. Keywords used were: *ultrasound, simulation, simulation-based, training, education, performance, confidence, confidence level, knowledge, knowledge level, impact, checklists, objectives, pre-brief, prebriefing period, debrief, and debriefing period*. Articles that were not published within the last five years were excluded, with the exception of a comprehensive literature review written in 2005. In order to be included in this review, journal articles had to be published in the English language, and demonstrate measurement of performance, confidence, or knowledge based on a simulation education experience. Articles also had to investigate the impact of having a debriefing period. All articles were screened by title and abstract. If the methods and results measured pertinent information the full article was screened. Following a thorough search, 20 journal articles, levels I-IV, were found and used to write this review of the literature (Appendix A).

Simulation

In recent years, simulation-based learning has become an integral part of education models (Kalaniti & Campbell, 2015). Simulation training allows participants to develop their technical skills and receive immediate feedback, which helps improve their comprehension and clinical performance (Kalaniti & Campbell, 2015; Wiggins et al., 2018). The ability to become proficient with skills in simulation before performing skills on patients provides participants with the knowledge and confidence to deliver a higher quality of patient care (Bortman et al., 2019; Griswold-Theodorson et al., 2015; Kalaniti & Campbell, 2015; Wiggins et al., 2018).

US simulation has been shown to improve student registered nurse anesthetists' (SRNAs) ability to perform regional anesthesia prior to entering the clinical arena. Hauglum et al. (2020) recently showed that novice SRNAs were able to improve their overall transverse abdominis plane block performance using simulation-based training with computer-guided US devices, ($p = 0.010$). In addition to improving performance during simulation sessions, it has been shown that improved performance carries over into the clinical setting. Ostergaard et al. (2019) displayed that radiology residents who receive simulation-based US training prior to clinical exposure performed better than the students who did not receive simulation training, ($p < 0.001$).

Simulation-based US training is also beneficial for experienced practitioners. Kim et al. (2017) presented evidence that practicing anesthesiologists who participated in a simulation-based ultrasound-guided regional anesthesia (UGRA) course went on to increase the number of blocks they performed in subsequent months. Overall, simulation-based training benefits any participant and is a great tool to prepare students for the clinical arena.

Knowledge/Confidence

There are several different uses for US in the clinical arena. Simulation-based training has been shown to improve the knowledge of participants on these uses. Shields & Gentry (2020) provided evidence that simulation training improved SRNAs knowledge of cardiac structures and recognition of those structures on US displays. Allowing students to develop this knowledge and learn what anatomic structures look like on US displays before entering clinical practice is beneficial to their transition into practice.

A large portion of US usage for anesthesia is related to UGRA. A systematic review of 12 studies found that UGRA knowledge improved greatly with simulation-based training (Chen et al., 2017). The use of simulation training is also great for effectively improving knowledge in a short period of time. Bortman et al. (2019) provided evidence that certified registered nurse anesthetists gained a significant improvement of knowledge in a 2-day simulation-based training course, ($p = 0.03$). Eroglu et al. (2018) also showed that medical students had an improvement in knowledge through 20 hours of US simulation training ($p < 0.0001$). Jensen et al. (2018) went even further and provided evidence that US novice medical students can attain a mastery learning level with less than two hours of simulation-based training and practice. The majority of these studies show simulation training does not require a large amount of time to increase the knowledge of participants.

US simulation-based training can be used to improve the confidence level of participants. Four articles were found that show both students and practicing providers can develop an increased level of confidence after participating in simulation-based education (Roark et al., 2020; Schwid et al., 2019; Spencer & Spencer, 2019; Wiggins et al., 2018). Furthermore, all of these aforementioned studies provided evidence of improved confidence following some form of US simulation training (Roark et al., 2020; Schwid et al., 2019; Spencer & Spencer, 2019; Wiggins et al., 2018). Wiggins et al. (2018) emphasized that deliberate practice using a checklist before simulation and then follow-up with a debriefing period as important features to help improve the overall confidence level of participants.

Prebriefing/Debriefing

Ensuring that learning objectives are defined is a key component to developing a successful simulation training session (Adamson, 2015). Objectives can be provided in a checklist and the overall consensus in the literature is that checklist provide a standardized routine which is important for learning to perform anesthesia care in a consistent manner (Wiggins et al., 2018). Clear objectives enhance the development of thoughts which help participants plan ahead to form strategies for success (Paige-Cutrara & Turk, 2017). Objectives can be delivered to the participants in a pre-simulation briefing which allows participants to feel more inclined to actively engage in the simulation as well as the debriefing period (Kolbe et al., 2015). Using this design characteristic enables the instructor to clarify expectations and establish the goals of the simulation training experience (Kolbe et al., 2015). Paige-Cutrara & Turk (2017) provided evidence that prebriefing can positively impact simulation training by improving nursing student competency performance ($p < 0.001$).

In addition to pre-simulation briefing, post-simulation debriefing has also been shown to improve learning outcomes. Issenberg et al. (2005) wrote a comprehensive literature review using 109 studies, 51 of which focused on the feedback portion of simulation-based education.

Issenberg et al. (2005) determined that educational feedback was the most important component of simulation-based learning. Educational feedback can easily take place during a debriefing period following the simulation training experience. Thus, having a debriefing session should be an important part of all simulation-based education curriculum.

Bae et al. (2019) presented a new debriefing protocol developed for simulation-based education at the Nursing College of Yonsei University. Students who participated in the project noted that their clinical reasoning competency improved with a thorough debriefing process (Bae et al., 2019). Having a debriefing session also facilitates self-reflection and can improve both technical and non-technical skills learned throughout a simulation training experience (Ryoo & Ha, 2015). Overall, the use of debriefing after simulation training is good practice and aids in the learning process of participating students.

Conclusion

Simulation-based education improves the overall performance of participants (Kalaniti & Campbell, 2015; Wiggins et al., 2018). Gaining knowledge through simulation training before entering the clinical arena can aid in a smoother transition to clinical practice (Bortman et al., 2019; Griswold-Theodorson et al., 2015; Kalaniti & Campbell, 2015; Wiggins et al., 2018). Learning in a simulation environment increases the confidence level of participants which can lead to a better quality of patient care (Roark et al., 2020; Schwid et al., 2019; Spencer & Spencer, 2019; Wiggins et al., 2018). Having a pre-simulation briefing allows simulation objectives to be clearly understood and enables students to improve learning outcomes (Kolbe et al., 2015; Paige-Cutrara & Turk, 2017; Wiggins et al., 2018). Using a debriefing session ties everything together and provides valuable educational feedback that improves comprehension and clinical reasoning (Bae et al., 2019; Ryoo & Ha, 2015).

Theoretical Framework

Jeffries Simulation Framework

The Jeffries simulation framework is a middle-range theory that was created using theoretical literature and empirical evidence (Lafond & Van Hulle Vincent, 2012). It was created to aid educators in designing simulation experiences that provide relevant variables for successful learning (Jeffries, 2005). This framework was chosen to guide the process of designing, implementing, and evaluating an effective simulation experience that would positively impact learning outcomes for students participating in this DNP project.

This simulation framework recognizes five major components that interact to bring about favored outcome variables from a simulation education experience. The five components are *educator, student, educational practices, design characteristics of simulation, and outcomes* (Jeffries, 2005). The first portion of the framework involves the teacher, student, and educational practices interaction (Jeffries, 2005). The interactions of these three components then go on to influence the design characteristics and outcomes that are desired (Jeffries, 2005).

The focus of this DNP project is directed at improving the components designated as design characteristics and outcomes. More specifically, this project seeks to add a debriefing variable to the current practice. Using the Jeffries simulation model, depicted in Appendix B, a new simulation educational experience will be designed and implemented to view how these newly added variables will impact the knowledge and self-confidence of the participants.

PEARLS Debriefing Framework

Eppich and Cheng (2015) developed the Promoting Excellence and Reflective Learning in Simulation (PEARLS) framework (Appendix C). Eppich and Cheng developed this framework with the intention to help guide debriefing periods following simulation training, and it is recommended for such use by the National League for Nursing (NLN). The framework divides debriefing into four phases: the reaction phase, the description phase, the analysis phase, and the summary phase (Eppich & Cheng, 2015). This framework was chosen to guide and give structure to implementing a debriefing period for this DNP project.

In the PEARLS framework, the reaction phase is meant to allow the student to express how they are feeling following the simulation experience (Eppich & Cheng, 2015). During the description phase the student is encouraged summarize the simulation experience (Eppich & Cheng, 2015). The analysis phase is then used to transition into discussion, feedback and teaching (Eppich & Cheng, 2015). Questions can be directed to make this phase more of a learner self-assessment or it can be more of a directive feedback and teaching phase by the instructor (Eppich & Cheng, 2015). They summary phase is used to cover main learning points and can also be either instructor guided, or learner guided based on the questions that are used (Eppich & Cheng, 2015). Each phase is broken down in a debriefing script to help assist simulation instructors implement this debriefing model (Appendix D). This example will be used to help design a debriefing script for this DNP project.

Goals, Objectives, and Expected Outcomes

This project has three specific aims: 1) to evaluate the effect of a debriefing component on SRNAs satisfaction after US simulation for vascular access; 2) to evaluate the effect of a debriefing component on SRNAs confidence in performing US techniques for vascular access; 3) to evaluate the effect of a debriefing component on SRNAs knowledge regarding US use for vascular access. The desired effect was to have greater effects on satisfaction, confidence, and knowledge with the addition of a debriefing period compared to the control group which used the current practice with no debriefing period.

Project Design

This DNP project used a quality improvement design. Quantitative data was collected with post-test questionnaires and surveys. The data was used to assess for differences in satisfaction, confidence, and knowledge scores between the experimental and control group.

Project Site and Sample

The project site was located on the main campus at Marian University of Indianapolis. The Marian University Certified Registered Nurse Anesthetist Program simulation lab located on campus was utilized to measure the proposed intervention. There is single simulation lab with one high-fidelity mannequin, four airway mannequins, and two vascular access mannequins on which student can practice prior to skill testing. Students practice in the same space in which testing of skills occurs. The debriefing period and post-test survey took place in a small office space located outside the simulation lab.

The Marian University Certified Registered Nurse Anesthetist Program is a Bachelorette of Science in Nursing to DNP in Nurses Anesthesia Tract. Following completion of the program each student will be given the ability to obtain their Certified Registered Nurse Anesthetist certification by taking the national board exam. The program has one cohort matriculate per year. The number of students admitted to each cohort continues to increase every year. The cohort that was analyzed in this quality improvement project contained 24 SRNAs. Each student was given the option following US simulation to participate in the project. Participants were required to be SRNAs from the graduating class of 2023 who were in enrolled in the Anesthesia Principles Simulation I Course.

Methods

Prior to conducting this project, IRB approval was obtained from Marian University. Following IRB approval, the debriefing script was developed utilizing questions and format from the PEARLS debriefing script (Appendix D), which was recommended by the NLN. After development of the debriefing script, the knowledge test was developed using information gathered from the *Nurse Anesthesia* textbook (Nagelhout & Sass, 2018). Content validity for the knowledge test was then received by anesthesia experts at Marian University.

Prior to the test out day, students were given a reading assignment provided by the simulation instructor. Students also received a skills checklist developed by the program director and given the ability to practice the skills on their own in the simulation lab. The test out for this skill took place on two different days. The group of 24 students were randomly divided into two groups by the instructor in charge of the course. On test-out day each student received one-on-one simulation testing with the instructor which lasted approximately 20 minutes. Following the training session each student met with the DNP student in the office outside the simulation lab. The group of students that had simulation test out on the first day was chosen to the be the control group and the group of students that had test out on the second day was chosen to be the experimental group. Each student in the control group were asked to complete the post-test surveys following simulation. Each student in the experimental group received a formal debriefing period with a structured guide based on the PEARLS debriefing model (Appendix D) and then completed the post-test surveys. Each debriefing session took approximately 10 minutes.

Measurement Instruments

Student Satisfaction and Self-confidence Survey

Student satisfaction and self-confidence were measured by utilizing the NLN student satisfaction and self-confidence survey (Appendix E). This tool is comprised of 13 questions. Each question is a five-point Likert scale question. The survey contains 2 subscales, student satisfaction and self-confidence. The student satisfaction subscale contains five questions which addresses the student's satisfaction with the teaching methods and thus their ability to learn during simulation. The self-confidence subscale contains eight questions that addresses the student's self-confidence in the knowledge and skills they acquired throughout the simulation experience. The data was evaluated for each subscale. The sum of the subscales were compared between groups, and higher scores were equivalent to better satisfaction and more self-confidence. Franklin et al. (2014) provided evidence that the student satisfaction and self-confidence survey is sufficiently reliable and valid for use in research. The reliability was determined with Cronbach's alpha and found to be 0.94 for satisfaction and 0.87 for self-confidence.

Knowledge Survey

Knowledge gain was assessed using a post-test survey. The questions for the knowledge test were created using information provided by *Nurse Anesthesia* (Nagelhout & Sass, 2018). This tool was comprised of five questions. There was one select all that apply, two true or false, and two multiple choice questions (Appendix F). The questions focused mostly on US machine content and use (Appendix F). The test received content validity by three anesthesia experts at Marian University prior to use. The test contained questions regarding the US machine and its appropriate use which help students obtain vascular access (Appendix F).

Data Collection

Data was collected by the DNP student project designer. Data collection took place following the simulation training exercise for the control group and after the debriefing session for the experimental group. Paper surveys were used to ensure that each student filled out the survey prior to leaving the building. After the student filled out the survey it was placed into a collection folder. Two separate folders were used, one for the control and once for the experimental. The surveys were resorted randomly upon removable from the folder to ensure anonymous collection of data.

Ethical Considerations

Participant consent was received prior to starting the debriefing period. There was minimal risk included in this project. Potential risk included an uncomfortable feeling when speaking about the simulation experience with DNP student project designer. Collection of survey responses was done anonymously. Only aggregate data was collected. The only person dealing with aggregate data was the DNP student project designer.

Data Analysis

Data and descriptive statistics were analyzed and computed using IBM SPSS Statistics (Version 27). Demographic data was the first to be analyzed and calculated using this statistical program. Measures of frequency were calculated for the demographic data (Table 1). A *t* test was used to compare the differences in mean knowledge test scores. A Wilcoxon Signed Rank test was used to determine the differences in satisfaction and self-confidence survey scores between the control and experimental group. Although the sample size of each group was small the *t* test is robust enough to handle violation of the assumptions of normal distribution (Cronk, 2016).

Results

All SRNAs that participated in this project completed the post-test surveys. The post-test surveys included the knowledge test and student satisfaction and self-confidence survey which contained two subscales. Demographic data for the sample is listed in Table 1. Most participants were in the 25-35 age range (75%), identified as female (66.7%), and had 1-5 years of experience (46.0%).

Table 1.

Demographics of 24 SRNAs participants

Characteristics	n	%
Age Range	18	75.0
25-35	5	21.0
36-46	1	4.0
47-57		
Sex		
Female	16	66.7
Male	8	33.3
Years of Experience as Registered Nurse		
1-5	11	46.0
6-11	8	33.0
12-17	4	17.0
18-23	1	4.0

Knowledge Test

An independent *t* test was calculated using the mean knowledge test scores for the control and experimental group. There were five questions included on the knowledge test. The control group's most commonly missed questions included basic movements when using the US, knowing the frequency medical US machines operate, and understanding tissue echogenicity. In contrast, the experimental group's most commonly missed question only included understanding the when to use high or low frequency US probes. The mean score for the control group was 33.3 (SD = 27.4), and the mean for the experimental group was 80.0 (SD = 19.1). A significant increase in score between the control and experimental group was found ($p = 0.00$). Data for the *t* test pertaining to knowledge scores is listed in Table 2.

Table 2.

Results of Knowledge Scores

Control		Experimental		*t*	*p*
M	SD	M	SD		
33.3	27.4	80.0	19.1	4.84	0.00

Note: An independent t test was calculated to compare the control group mean knowledge test score and the experimental group mean knowledge test score. Statistically significant change at $p < 0.05$.

Satisfaction Subscale

Table 3 provides data for the Wilcoxon Signed Rank test comparing satisfaction scores between the control and experimental group. The mean scores for the control group ranged from 3.75 to 4.00 and the experimental group scores ranged from 4.17 to 4.33. The summed satisfaction score for the control group was 19.1 (SD = 0.11), and the summed score for the experimental group was 21.1 (SD = 0.07). Results were not statistically significant between the control and experimental group ($p = 0.06$).

Table 3.

Results of Satisfaction Subscale

Item	Control		Experimental		*p*
	M	SD	M	SD	
Satisfaction 1	3.83	1.12	4.17	1.12	0.33
Satisfaction 2	3.75	1.14	4.33	0.65	0.09
Satisfaction 3	3.75	1.29	4.17	1.19	0.35
Satisfaction 4	4.00	1.04	4.17	1.19	0.67
Satisfaction 5	3.75	1.22	4.25	1.14	0.27

Summed Satisfaction	19.1	0.11	21.1	0.07	0.06

Note: Wilcoxon Signed Rank test was used. Statistically significant change at p < 0.05.

Self-Confidence Subscale

The range of mean self-confidence scores for the control group was 3.67 to 4.25 and the range for the experimental group was 4.17 to 4.33. The summed score for the control group was 32.3 (SD = 0.22), and the summed score for the experimental group was 33.9 (SD = 0.20). The difference between summed scores that measured self-confidence were found to be statistically significant (p = 0.01). Data for the Wilcoxon Signed Rank test comparing the difference between self-confidence scores is displayed in Table 4.

Table 4.

Results of Self-Confidence Subscale

Item	Control		Experimental		*p*
	M	SD	M	SD	
Satisfaction 1	3.67	0.89	3.92	1.00	0.62
Satisfaction 2	4.00	0.85	4.17	0.94	0.66
Satisfaction 3	3.75	0.87	4.25	0.75	0.10
Satisfaction 4	4.08	0.90	4.00	0.95	0.86
Satisfaction 5	4.17	1.34	4.42	0.67	0.77
Satisfaction 6	4.25	0.62	4.42	0.52	0.42
Satisfaction 7	4.08	0.90	4.42	0.52	0.20
Satisfaction 8	4.25	0.97	4.33	0.65	0.82
Summed Self-Confidence	32.3	0.22	33.9	0.20	0.01

Note: Wilcoxon Signed Rank test was used. Statistically significant change at p < 0.05.

Discussion

Improvements in SRNA's knowledge scores were demonstrated between the control and experimental group in this project. The results from this project indicate that a formal debriefing period following an US simulation education can impact the knowledge obtained by SRNAs. These results were similar to the results presented by Bae et al. (2019). Past literature has also shown that simulation-based training aids in improving the knowledge of its participants (Bortman et al., 2019; Chen et al., 2017; Eroglu et al., 2018; Jensen et al., 2018; Shields & Gentry, 2020). The results from this project indicate that a debriefing period can enhance the simulation knowledge gain following the simulation experience. Thus, with these results it can be inferred that a debriefing period should be considered a cornerstone for any simulation design.

The results from the summed score comparison for the self-confidence subscale demonstrated that SRNAs from the experimental group were more confident than SRNAs from the control group following simulation ($p = 0.01$). Simulation-based education has been shown to increase the confidence level of participants in the past (Roark et al., 2020; Schwid et al., 2019; Spencer & Spencer, 2019; Wiggins et al., 2018). This project helps to provide more information on this subject and indicates that simulation with a debriefing period can be beneficial to the confidence gain of simulation participants.

Although there was a difference between the summed scores for the satisfaction subscale it was not found to be statistically significant ($p = 0.06$). The experimental group may not have gained a significant increase in satisfaction because this survey took into consideration the entire simulation experience. It did not specifically measure the debriefing component itself. Students who may have been dissatisfied with the simulation component may not have been dissatisfied with the debriefing component. However, their dissatisfaction with the simulation component undoubtedly influenced their overall satisfaction scores.

Strengths and Limitations

A strength of this project is that it demonstrates simulation education has a potential benefit for SRNA knowledge and confidence gain. Moreover, simulation education with the implementation of a debriefing period can enhance the simulation benefits. However, the project was limited by a number of different factors.

First, this project used convenience sampling and had a limited sample size. There were only 12 participants for each group which limits the ability to determine statistical significance. A second noticeable limitation to this project was its proximity to final exams. Some students were noticeably distracted with finals week approaching the following week, as well as a large pharmacology exam they were required to take the following day. Finally, this project was the 7th simulation project they had participated in throughout the semester. Therefore, fatigue from participating in other simulation projects and filling out the NLN satisfaction and self-confidence survey for other projects may have affected their results. It is also possible that students may have been comparing this simulation experience to a previous one, and if they did not enjoy the format of the US simulation compared to a previous simulation their scores could be lower.

Recommendations

In future studies, it would be beneficial to measure a larger sample size. If this project was repeated with the entering class and combined with the data from this project, there would be approximately 29 samples for each group. Another option would be to use the two different US simulation exercises. The US vascular access simulation in the spring and the US regional anesthesia simulation in the summer could both be used. The vascular access simulation could serve as a control and the regional anesthesia simulation could serve as the experimental test. It would also be beneficial to conduct the project well in advance of final exam week and on a week that did not have an exam the following day. This would greatly reduce the amount of distraction students have and allow them to fully focus on the simulation experience.

Implications for Practice and Future Research

This project shows that a formal debriefing period can enhance the students' knowledge. This project also shows a formal debriefing period can help increase the student self-confidence. If students can gain more knowledge and increased self-confidence due to the addition of a debriefing period post simulation training, then it should be added as a fundamental component of US simulation education for nurse anesthesia programs.

After analyzing the results, this project may have benefitted from a survey that measured the debriefing period impact on students' satisfaction and self-confidence in addition to the overall simulation survey. In future studies it would be beneficial to develop a survey that specifically measures the debriefing components impact on students' satisfaction and self-confidence apart from the rest of the simulation experience. This may provide better evidence to support the benefit of the debriefing period and its addition to simulation education curriculum.

Conclusion

This project provides further insight on the benefit a formal debriefing period can add to student learning outcomes. More specifically, it shows that students' knowledge and self-confidence scores increase following a debriefing period post simulation training. Satisfaction scores increased slightly in the experimental group, but this was not a statistically significant result. Although satisfaction did not increase significantly, it is still evident that students benefitted from the debriefing period based on the increase in knowledge and self-confidence scores for the experimental group. Thus, with the results from this project, SRNAs in nurse anesthesia programs would benefit from a formal debriefing period following simulation training. Additional studies utilizing surveys created to measure students' satisfaction and self-confidence scores specific to the debriefing period itself could provide further evidence for its benefit. The addition of more efficient methods to enhance student learning outcomes will improve the way our education system produces future healthcare providers. Efforts to improve simulation education must continue to be explored to help make learning a more efficient process in our ever-changing learning environments.

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Appendix A

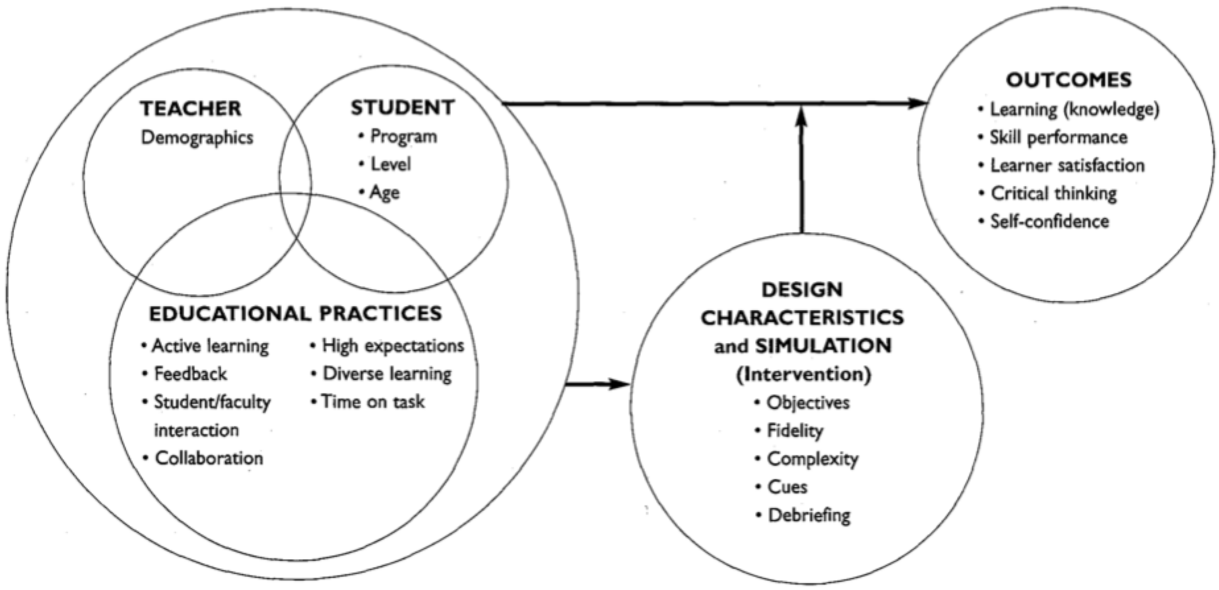
Literature Review Matrix					
Reference in APA format	**Level of Evidence**	**Variables**	**Sample**	**Instruments**	**Results**
Adamson, K. (2015). A systematic review of the literature related to the NLN/Jeffries simulation framework. *Nursing Education Perspectives, 36* (5), 281–291. https://doi.org/10.5480/15-1655	1	Systematic Review: Variables were components of the simulation framework	153 Resources	Cumulative Index of Nursing and Allied Health Literature (CINAHL)	Three recurring themes: Simulation, Fiedelity, and Debriefing are discussed in the literature. Key issues including gaps and best practice were discussed.
Bae, J., Lee, J., Jang, Y., & Lee, Y. (2019). Development of simulation education debriefing protocol with faculty guide for enhancement clinical reasoning. *BMC Medical Education, 19* (197). https://doi.org/10.1186/s12909-019-1633-8	4	Different debriefing content: perception, information processing, analysis, deliberation, metacognition	12 articles reviewed to develop protocol and for applicability evaluation used senior level undergraduate nursing students	PubMed, CINAHL, Riss, KoreaMed databases	The debriefing protocol allowed participants of the study to develop a better understanding of their clinical reasoning and improved their reasoning competancy.
Bortman, J., Mahmood, F., Mitchell, J., Feng, Baribeau, Y., Wong, V., Coolidge, B., Bose, R., Gao, Z., Jones, S., & Matyal, R. (2019). Ultrasound-guided intravenous line placement course for certified registered nurse anesthetists: A necessary next step. *American Association of Nurse Anesthetist, 87* (4), 269-275. https://www.aana.com/docs/default-source/aana-journal-web-documents-1/ultrasound-guided-intravenous-line-placement-course-for-certified-registered-nurse-anesthetists-a-necessary-next-step-august-	4	Measurement: dependent variable (meausre of knowledge US use on pretest and postest) Treatment: quasi-independent variable (participants receive 2 days of training in US use)	25 CRNAs	Pretest-posttest and post survey	Significant improvement of cognitive understanding from the pretest versus posttest score (p = 0.03). 3 week post survey found each part of the course to be effective at providing an understanding of material.
Chen, X. X., Trivedi, V., AlSafan, A. A., Todd, S. C., Tricco, A. C., McCartney, C. J. L., & Boet, S. (2017). Ultrasound-guided regional anesthesia simulation training. *Regional Anesthesia and Pain Medicine. 42* (6), 741-748. https://doi.org/10.1097/AAP.0000000000000639	1	Systematic Review: Variables were knowledge and skills	12 studies	MEDLINE, EMBASE, CINHAHL, Cochrane Central Register of Controlled Trials, and ERIC databases	Knowledge and skills improved significantly after simulation based training for ultrasound-guided regional anestheisia.
Eroglu, O., & Coskun, F. (2018). Medical students' knowledge of ultrasonography: Effects of a simulation-based ultrasound training program. *Pan African Medical Journal.* 1-7. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6201616/	4	Measurement: dependent variable (meausre of knowledge US use on pretest and postest) Treatment: quasi-independent variable (participants receive 20 hours of training in US use)	96 medical students	pretest and post test theoretical exam and practical application exam before and after training: pretest-postest	96 medical students in their final year improved on there theoretical exam scores posttest scores compared to their pretest scores. These students also displayed a significant increase in their practical application examination in the postest scores versus the pretest scores (p < 0.0001).

Griswold-Theodorson, S., Ponnuru, S., Dong, C., Szyld, D., Reed, T., & McGaghie, W. C. (2015). Beyond the simulation laboratory: A realist synthesis review of clinical outcomes of simulation-based mastery learning. *Academic Medicine: Journal of the Association of American Medical Colleges*, *90*(11), 1553–1560. https://doi.org/10.1097/ACM.0000000000000938	1	Literature Review: Variables were the improvements after simulation training	14 studies	Multiple databases	After simulation there was improvement in performance, patient discomfort, procedural time, and complication rates.
Hauglum, S., Vera, C., Alves, S. L., & Tran, C. (2020). Use of computer-assisted instrument guidance technology by student registered nurse anesthetists for simulated invasive procedures. *American Association of Nurse Anesthetist, 88*(4), 289-298. https://www.aana.com/docs/default-source/aana-journal-web-documents-1/hauglum_r162af97fc17c4367ad00a9c264e04a34.pdf?sfvrsn=641e5a_4	3	Dependent Variable: student (each student served as his or her own control) Independent Variables: Computer Assisted Instrument Guidance (CAIG) and US alone	26 SRNAs	Preprocedure survey for demogrphics and prior experience, and perceived confidnece level. Tasklist specific checklist tool (TSCST), Generic technical skills global rating scale (GRS), anonymous post survey assessing experience with both techniques.	Higher mean scores for all item in the global rating scale and overall performance. The use of CAIG in simulation with porcine model provided improvement in techinical skills of novice SRNAs compared to the use US alone. Generic technical skills were significantly higher with CAIG versus US alone.
Issenberg, S. B., McGaghie, W. C., Petrusa, E. R., Lee Gordon, D., & Scalese, R. J. (2005). Features and uses of high-fidelity medical simulations that lead to effective learning: A BEME systematic review. *Medical Teacher*, *27*(1), 10–28. https://doi.org/10.1080/01421590500046924	1	Educational feedback, repetative practice, curriculum integration	109 simulation-based education studies	ERIC, MEDLINE, PsycINFO, Web of Science, and Timelit databases	Educational feedback (debriefing period) is the most important component of simulation-based training.
Jensen, J. K., Dyre, L., Jorgensen, M. E., Andreasen, L. A., & Tolsgaard, M. G. (2018). Simulation-based point-of-care ultrasound training: A matter of competency rather than volume. *Acta Anaesthesiologica Scandinavica, 62*, 811-819. https://doi.org/10.1111/aas.13083	3	Independent variable: Fast protocol training Dependent variable: prestest/posttest scores	25 Novice senior medical students	Five training modules based on the FAST protocol	A mastery learning level was attained by ultrasound novice medical students who participated in ultrasound simulation training. Test scores displayed that mastery level took approximately 2 hours to achieve.
Kalaniti, K., & Campbell, D. M. (2015). Simulation-based medical education: Time for a pedagogical shift. *Indian Pediatrics. 52*(1), 41-45. https://doi.org/10.1007/s13312-015-0565-6	1	Role of stress in simulation, skills training, Fidelity, stages of simulaiton, type of simulation, simuliaton facility	31 Articles	Databases	Simulation cannot replace exposure through patient care but it can promote learning while maintaining patient safety.

Kim, T. E., Ganaway, T., Harrison, T. K., Howard, S. K., Shum, C., Kuo, A., & Mariano, E. R. (2017). Implementation of clinical practice changes by experience anesthesiologists after simulation-based ultrasound-guided regional anesthesia training. *Korean Journal of Anesthesiology, 70* (3), 318-326. https://doi.org/10.4097/kjae.2017.70.3.	4	Idependent variable: one day UGRA course Dependent variable: procedural volume	46 practicing anesthesiologist	precourse and post course surveys	A one day simultaion-based ultrasound-guided regional anesthesia (UGRA) training course resulted in a significant increase in the number of blocks performed each month by practicing anesthesiologist.
Kolbe, M., Grande, B., & Spahn, D. R. (2015). Briefing and debriefing during simulation-based training and beyond: Content, structure, attitude and setting. *Best Practice & Research Clinical Anaesthesiology, 29* (1), 87–96. https://doi.org/10.1016/j.bpa.2015.01.002	1	Literature Review: Variables include briefing and debriefing	82 Resources	Databases	Briefings provide participants with orientation, clarity of expectations, and phsychological safety. Debriefing is effective at improving performance.
Ostergaard, M. L., Nielsen, K. R., Albrecht-Beste, E., Ersboll, A. K., Konge, L., & Nielsen, M. B. (2019). Simulator training improves ultrasound scanning performance on patients: A randomized controlled trial. *European Radiology, 29*, 3210-3218. https://doi.org/10.1007/s00330-018-5923-z	1	Idependent variable: simulator-based training Control: No intervention prior to standard clincal ultrasound training Dependent Variable: Performance score	20 radiology students from 10 different hospitals	Objective Structured Assessment of Ultrasound Skills (OSAUS)	Performance scores for the group of participcants who had simulation training were significantly higher than those who had no trainng prior to clinical ultrasound traininng of patients ($p < 0.001$).
Page-Cutrara, K., & Turk, M. (2017). Impact of prebriefing on competency performance, clinical judgment and experience in simulation: An experimental study. *Nurse Education Today, 48* , 78–83. https://doi.org/10.1016/j.nedt.2016.09.012	2	Independent variable: structured prebriefing Control: No intervention Dependent variable: Competency, clinical judgement, and experience	76 nursing students	Creighton Competency Evaluation Instrument and Prebriefing Experience Scale	Competency performance significantly increased ($p < 0.001$).
Roark, A. A., Ebuoma, L. O., Ortiz-Perez, T., Sepulveda, K. A., Severs, F. J., Wang, T., Benveniste, A. P., & Sedgwick, E. L. (2018). Impact of simulation-based training on radiology trainee education in ultrasound-guided breast biopsies. *Journal of the American College of Radiology, 15* (10), 1458–1463. https://doi.org/10.1016/j.jacr.2017.09.016	4	Idenpendent variable: Simulation course Depedent variables: comfort and confidence levels	21 radiology residents	precourse and post course surveys	Participants recevied significant improvement in their comfort and overal procedural confidence level following simulation-based ultrasound training.

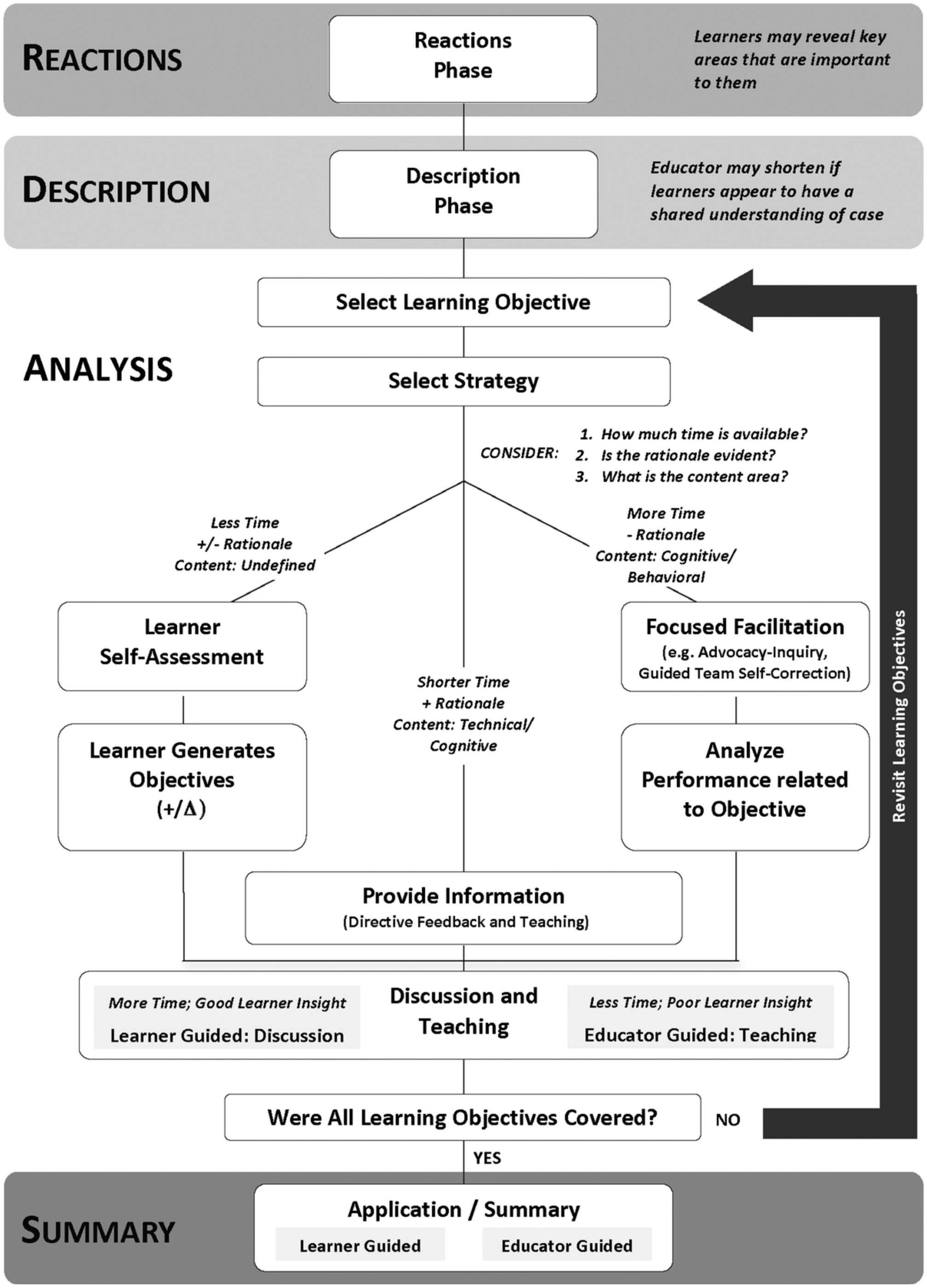
Ryoo, E. N., & Ha, E. (2015). The importance of debriefing in simulation-based learning: Comparison between debriefing and no debriefing. Computers, Informatics, Nursing, *33*(12), 538-545. https://doi.org/10.1097/CIN.0000000000000194	1	Idependent variable: debriefing group Control variable: Group with no debriefing Dependent variable: Clincal competancy and self-reflection score	49 nursing students	Clincal Performance Competancy Scale (Instructor Checklist)	Students in the debriefing group had a higher level of clinical performance competancy, satisfaction with simulation training, and self reflection. The debrief period was an important component for simulation-based learning. It facilitated self reflection and also reinforced learning to improve techincal skills. A debrief period with the instructor maximizes simulation-based training success.
Schwid, M., Harris, O., Landry, A., Eyre, A., Henwood, P., & Kimberly, H. (2019). Use of a refresher course increases confidence in point-of-care ultrasound skills in emergency medicine faculty. *Cureus, 11*(8), e5413. https://doi.org/10.7759/cureus.5413	4	Independent variable: Simulation course Dependent variabe: Confidence	60 EM physicians	Pre and Post simulation questionare	Training provided physicians with increased confidence level following US simulaiton sessions.
Shields, J. A., & Gentry, R. (2020). Effect of simulation training on cognitive performance using transesophageal echocardiography. *American Association of Nurse Anesthetist. 88*(1), 59-65. https://www.aana.com/docs/default-source/aana-journal-web-documents-1/effect-of-simulation-training-on-cognitive-performance-using-transesophageal-echocardiography-february-2020.pdf?sfvrsn=af8dd107_6	3	Measurement: Dependent Variable (Measure on pretests/posttest exam scores). Groups: Quasi-Independent Variables (students who receive web-based education over 1 week) and (studetns who received in person simulation for 2 hrs)	71 SRNAs	Video based (ExamSoft) assessment tool	One group underwent web-based simulation training and one group underwent in person simulation training. Both groups showed improvement, but the SRNAs who underwent simluation training in person scored higher on posttest evaluations.
Spencer, T. R., & Bardin-Spencer, A. J. (2020). Pre- and post-review of a standardized ultrasound-guided central venous catheterization curriculum evaluating procedural skills acquisition and clinician confidence. *The Journal of Vascular Access*, *21*(4), 440–448. https://doi.org/10.1177/1129729819882602	4	Idenpendent variable: Simulaiton course Dependent variables: Confidence, US skills, and procedural compliance	1,238 physicians and non-physician groups	Pre and Post surveys	Standardized simulatioin training improved the confidence for both physician and non-physician participants.
Wiggins, L. L., Morrison, S., Lutz, C., & O'Donnell, J. (2018). Using evidence-based best practices of simulation, checklists, deliberate practices, and debriefing to develop and improve a regional anesthesia training course. *American Association of Nurse Anesthetist. 86*(2), 119-126. https://www.aana.com/docs/default-source/aana-journal-web-documents-1/using-evidence-based-best-practices-of-simulation-checklists-deliberate-practice-and-debriefing-to-develop-and-improve-a-regional-anesthesia-training-course-april-2018.pdf?sfvrsn=c2505fb1_8	4	Measurement: Dependent Variable (Precourse/Postcourse comfort and confidence levels). Group: Quasi-Independent Variables (4 hour online course and Hands on practice).	49 CRNAs	Precourse demographic survey and atttitude survey, skills assessment/ checklist, postcourse survey	The confidence and comfort level for epidural and spinal blocks were higher when compared to results from prior to simulation training.

Appendix B



"Jeffries Simulation Model," by P. R. Jeffries, 2005, *Nursing Education Perspectives, 26*(2), 96-103(https://journals.lww.com/neponline/pages/articleviewer.aspx?year=2005&issue=03000&article=00009&type=abstract). Copyright 2005 by National League for Nursing Inc. Reprinted with permission.

Appendix C



"PEARLS Debriefing Framework," by Eppich & Cheng, 2015, *Journal of the Society for Simulation in Healthcare*, *10*(2), 106–115(https://doi.org/10.1097/SIH.0000000000000072).

Appendix D

Setting the scene (may also occur before the first scenario debriefing, may abbreviate or omit for subsequent debriefings):

"I'll spend about XX minutes debriefing the case with you. First, I'll be interested to hear how you are feeling now that that case is over; second, I'd like someone to describe what the case was about to make sure we are all on the same page. Then, we'll explore the aspects of the case that worked well for you and those you would manage differently and why. I'll be keen to hear what was going through your mind at various points in time. We'll end by summarizing some take-home points and how to apply them in your clinical practice."

Reaction

- "How are you feeling?"

Potential follow-up question:

- "Other reactions?" or "How are the rest of you feeling?"

Description

- "Can someone summarize the case from a medical point of view so that we are all on the same page?"; "From your perspective, what were the main issues you had to deal with?"

Potential follow up questions:

- "What happened next?"; "What things did you do for the patient?"

Analysis

Signal the transition to the analysis of the case and frame the discussion:

- "Now that we are clear about what happened, let's talk more about that case. I think there were aspects you managed effectively and others that seemed more challenging. I would like to explore each of these with you."

Learner self-assessment (eg, plus-delta)	*Directive feedback and teaching*	*Focused facilitation*
"What aspects of the case do you think you managed well and why?"	Provide the relevant knowledge or tips to perform the action correctly.	*(eg, alternatives—pros and cons; self-guided team correction; advocacy-inquiry)*
"What aspects of the case would you want to change and why?"	• "I noticed you *[behavior]*. Next time, you may want to … *[suggested behavior]*… because *[provide rationale]*."	• Specifically state what you would like to talk about ("I would like to spend a few minutes talking about XXX.")
Close performance gaps selectively using directive feedback and teaching or focused facilitation		*Elicit underlying rationale for actions: see SDC 2, http://links.lww.com/SIH/A175 for advocacy-inquiry approach*

Are there any outstanding issues before we start to close?

Application/summary

- *Learner guided:* "I like to close the debriefing by having each you state one two take-aways that will help you in the future."
- *Educator guided:* "In summary, the key learning points from this case were …"

"PEARLS Debriefing Script," by Eppich & Cheng, 2015, *Journal of the Society for Simulation in Healthcare*, *10*(2), 106–115(https://doi.org/10.1097/SIH.0000000000000072).

Appendix E

Student Satisfaction and Self-Confidence in Learning

Instructions: This questionnaire is a series of statements about your personal attitudes about the instruction you receive during your simulation activity. Each item represents a statement about your attitude toward your satisfaction with learning and self-confidence in obtaining the instruction you need. There are no right or wrong answers. You will probably agree with some of the statements and disagree with others. Please indicate your own personal feelings about each statement below by marking the numbers that best describe your attitude or beliefs. Please be truthful and describe your attitude as it really is, not what you would like for it to be. This is anonymous with the results being compiled as a group, not individually.

Mark:
1 = STRONGLY DISAGREE with the statement
2 = DISAGREE with the statement
3 = UNDECIDED - you neither agree or disagree with the statement
4 = AGREE with the statement
5 = STRONGLY AGREE with the statement

Satisfaction with Current Learning	**SD**	**D**	**UN**	**A**	**SA**
1. The teaching methods used in this simulation were helpful and effective.	○ 1	○ 2	○ 3	○ 4	○ 5
2. The simulation provided me with a variety of learning materials and activities to promote my learning the medical surgical curriculum.	○ 1	○ 2	○ 3	○ 4	○ 5
3. I enjoyed how my instructor taught the simulation.	○ 1	○ 2	○ 3	○ 4	○ 5
4. The teaching materials used in this simulation were motivating and helped me to learn.	○ 1	○ 2	○ 3	○ 4	○ 5
5. The way my instructor(s) taught the simulation was suitable to the way I learn.	○ 1	○ 2	○ 3	○ 4	○ 5
Self-confidence in Learning	**SD**	**D**	**UN**	**A**	**SA**
6. I am confident that I am mastering the content of the simulation activity that my instructors presented to me.	○ 1	○ 2	○ 3	○ 4	○ 5
7. I am confident that this simulation covered critical content necessary for the mastery of medical surgical curriculum.	○ 1	○ 2	○ 3	○ 4	○ 5
8. I am confident that I am developing the skills and obtaining the required knowledge from this simulation to perform necessary tasks in a clinical setting	○ 1	○ 2	○ 3	○ 4	○ 5
9. My instructors used helpful resources to teach the simulation.	○ 1	○ 2	○ 3	○ 4	○ 5
10. It is my responsibility as the student to learn what I need to know from this simulation activity.	○ 1	○ 2	○ 3	○ 4	○ 5
11. I know how to get help when I do not understand the concepts covered in the simulation.	○ 1	○ 2	○ 3	○ 4	○ 5
12. I know how to use simulation activities to learn critical aspects of these skills.	○ 1	○ 2	○ 3	○ 4	○ 5
13. It is the instructor's responsibility to tell me what I need to learn of the simulation activity content during class time..	○ 1	○ 2	○ 3	○ 4	○ 5

 Revised December 22, 2004

“Student Satisfaction and Self-Confidence in Learning Questionnaire,” by National League for Nursing, 2004 (http://www.nln.org/docs/default-source/default-document-library/instrument-2_satisfaction-and-self-confidence-in-learning.pdf?sfvrsn=0).

Appendix F

1. True or False, the in-plane or axial/longitudinal approach allows the entire length of the needle (including the tip) to be visualized within the plane of the ultrasound image.
    a. True
    b. False
2. The basic movements when scanning with the ultrasound probe are? Select all that apply.
    a. Sliding
    b. Alignment
    c. Guiding
    d. Tilting
    e. Rotation
3. True or False, higher-frequency ultra-sound probes are best suited for visualizing deeper structures?
    a. True
    b. False
4. At what frequencies does a medical ultrasound machine operates between?
    a. 5-15 MHz
    b. 2-9 MHz
    c. 2-13 MHz
    d. 4-16 MHz
5. Anechoic areas do not reflect ultrasound waves and therefore appear what color on the screen?
    a. Gray
    b. White
    c. Blue
    d. Black
    e. Red

Reference

Nagelhout, J. J., & Elisha, S. (2018). *Nurse anesthesia* (6th ed.). Elsevier.