Marian University

Leighton School of Nursing

Doctor of Nursing Practice

Final Project Report for Students Graduating in May 2024

Effectiveness of Utilizing the Anatomage Table to Teach a Neuraxial Block

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Abstract

Neuraxial blocks are widely used by anesthesia providers in primarily orthopedic and obstetric populations. In many anesthesia programs, education surrounding regional blocks is limited to the classroom setting without thorough training on anatomy. The Anatomage table is a three-dimensional digital screen that allows students to perform virtual dissections and visualize various anatomical structures in the classroom setting. Review of the literature found that the Anatomage table improves visualization of structures, enhances anatomy comprehension, and serves as a useful supplemental tool. This Doctor of Nursing Practice (DNP) project evaluates the effectiveness of the Anatomage table in enhancing Student Registered Nurse Anesthetist's (SRNA) knowledge and confidence in performing neuraxial blocks, potentially informing its integration into anesthesia programs. This quality improvement project design utilized an educational intervention in addition to a pretest-posttest format containing a variety of knowledge based quantitative questions, confidence questions and Likert scale questions. A sample of 21 Marian University first-year SRNAs participated in the educational intervention session, and 7 students from the same class served as the control group. Participants who used the Anatomage table demonstrated a significant increase in knowledge (p=0.001) and reported higher satisfaction and self-confidence ($p < .05$), compared to the control group. However, the difference in knowledge scores between the intervention and control groups was not statistically significant (U=41, p=0.073). By incorporating this tool, SRNAs will be able to gain a deeper knowledge of various topics and be more confident in the clinical setting, allowing them to provide safe and expert care to patients.

Keywords: SRNA, Neuraxial blocks, Anatomage table, education, and virtual dissection

Effectiveness of Utilizing the Anatomage Table to Teach a Neuraxial Block

Student Registered Nurse Anesthetists (SRNAs) must learn an in-depth knowledge of anatomy and physiology of the human body essential and fundamental in performing the skills of safe and effective anesthesia. Currently students do not practice these procedures on cadavers; rather students develop skilled practice in the clinical setting under the supervision of licensed providers, on patients undergoing procedures. In the classroom, during introductory lessons of the human body's intricacies, it is helpful to have a visual aid present to assist the experience. This visual aid can be a traditional cadaver dissection lab or a virtual setting. Traditional anatomy teaching occurs in an anatomy lab, where students can visualize and touch structures underneath the skin such as nerves, veins, and arteries. However, anatomy labs can be expensive to maintain; there is a need for donated bodies and organs, and the number of dissections per body is limited (Martín, 2018). Additionally, human bodies need to be handled and disposed of by trained professionals and in an ethical manner (Martín, 2018). The question arises, are there advanced technological approaches that can help the student beyond textbook, simulation, cadaver, and patient learning?

The Anatomage table is a technologically advanced anatomy visualization tool designed for human anatomy education. It is a three-dimensional (3-D) interactive digital screen that allows for the visualization of human anatomy and virtual dissection. Students can visualize different layers of tissue, use a virtual knife to cut away at structures and study different organs within the body (Alasmari, 2021). Unlike an anatomy lab, embalming products, special permits, or licenses are not required for utilization (Martín, 2018). Students can make longitudinal, sagittal, and horizontal sections to understand the relationships between separate body parts and internal organs (Alasmari, 2021). Another benefit is that students can choose to view female or

male-specific structures eliminating the need for multiple cadavers. In addition, the Anatomage table can be used repeatedly without the need for frequent replacement of usable human tissues. After a student is finished utilizing the table, they can reset the digital cadaver allowing a clean slate for the next student (Alasmari, 2021).

Background

Central neuraxial blockades such as spinal and epidural blocks are a type of regional anesthetic that involves placement of local anesthetic medication onto or near the spinal cord (Nagelhout & Elisha, 2018). The utilization of regional nerve blocks in anesthesia has increased over the past few decades and is frequently used within orthopedic and obstetric populations. This is partially due to growing recognition of opioid sparing and multimodal anesthesia techniques (Albrecht & Chin, 2020). Regional anesthesia has had a prominent and effective role in minimizing opioid requirements during surgery (Albrecht & Chin, 2020). Additionally, when compared to general anesthesia, regional anesthesia is associated with a reduction in patient mortality, morbidity, and economic outcomes such as length of hospital stay (Albrecht & Chin, 2020).

At a University in Saudi Arabia, a high percentage of medical students reported satisfactions with using the Anatomage table as a supplemental tool to cadaver dissections, visualizing different body systems due to its ability to rotate the digital body and dissect various body parts, and allowing a profound understanding and visualization of anatomy through medical imaging (Alasmari, 2021).

The Anatomage table has proven to be effective, with improved test scores, and students' acceptance of the new technology (Anand & Singel, 2017). Accurate details along with many customizable features enhance students' interests leading to more effective teaching and

educational outcomes (Anand & Singel, 2017). Removing students from the book and placing them in an interactive setting encourages exploration, repeated attempts, and practice in a low stress environment with the content being taught (Brown et al., 2015). When it comes to learning hands-on skills, students require the material to be presented in an applicable, authentic, safe, and standardized simulation practice setting.

Problem Statement

When performing a neuraxial block, SRNA's must have a thorough understanding of all the landmarks including muscles, ligaments, bones, and nerves and their relationship to one another. Rather than receiving only a didactic lecture on anatomy, students should benefit by visually seeing the anatomical relationships to one another in a three-dimensional (3-D) setting (Baratz et al., 2019). With a 3-D representation of anatomy where neuraxial blocks are placed, SRNA's will have a more thorough understanding of how to perform the block and have the educational readiness and confidence to perform the block in the clinical setting. With this the following PICOT question was developed: Can the Anatomage table be successfully utilized to educate Marian SRNA's on how to effectively identify pertinent anatomy and perform a neuraxial block?

Needs Assessment & Gap Analysis

As part of their curriculum and future scope of practice, SRNAs are expected to learn the complexities of how to perform numerous types of regional nerve blocks. At Marian University, education surrounding regional nerve blocks is limited to the classroom setting and simulation lab. It would be beneficial to utilize a visual aid that allows a thorough understanding of the anatomy and the relationship of landmarks to one another in a 3-D setting. Currently, many SRNAs are learning how to perform numerous regional blocks in the operating room with

limited exposure or practice. By utilizing the Anatomage table to educate SRNAs of important anatomy and landmarks regarding regional blocks, this study predicts that SRNA's will enter the clinical setting feeling more prepared and knowledgeable regarding the appropriate technique for performing various blocks.

Review of Literature

Search Methodology

This literature review was completed to analyze articles regarding the use of the Anatomage table and its effectiveness in educating medical students. An initial search was conducted using *simulation*, *nursing*, *Anatomage table*, *virtual dissection*, *digital anatomy*, *cadaver lab and digital learning.* This literature review was conducted in November 2022 using the databases CINAHL and PubMed. Both databases were searched using the BOOLEAN phrases simulation OR nursing OR Anatomage table AND virtual dissection OR digital anatomy OR cadaver lab OR digital learning. The databases provided 42 search results that were reduced to exclude articles that were published over five years ago, and articles written in another language with no English translation. The remaining research articles were reviewed based on the following inclusion criteria: articles in English less than 5 years old, Anatomage table as an intervention, and individuals with anatomy backgrounds. The 42 articles were reduced to 14 articles that discussed or compared the effectiveness of using the Anatomage table as an educational tool or tested it against other tools. Please see Appendix A for the PRISMA flow diagram.

Literature Review Results

This literature review's initial search began with 42 articles. After applying both the exclusion and the inclusion criteria, the search was narrowed down to 14 articles. Appendix B shows the literature review matrix with the breakdown of information for each study.

Benefits of Simulation

Four out of fourteen studies conducted randomized control trials to determine whether students benefited from additional simulation training compared to traditional teaching methods (Padilha et al., 2019; Lebdai et al., 2020; Tamaki et al., 2019; Li et al., 2019). One trial evaluated the effectiveness of a clinical virtual simulation in relation to nursing students' "knowledge retention, clinical reasoning, self-efficacy, and satisfaction" (Padilha et al., 2019, p.1). Between the two groups there was no statistical difference between self-efficacy perceptions; however, the experimental group's knowledge improved significantly immediately after the intervention (p=.001) and two months later, (p=.02) and had higher satisfaction levels (p<.001) (Padilha et al., 2019). A similar prospective controlled study compared whether immersive virtual patient simulation (IVPS) was influential in improving students' academic performance. Students who participated in the IVPS achieved significantly higher grades in semester 2 than in semester 1 (p=0.002). Additionally, students in the IVPS group received higher grades than the control groups in both semesters 1 and 2 (p<0.003) (Lebdai et al., 2020). An additional advantage was students had higher levels of satisfaction with "overall interest, ergonomics, realism, immersion and training efficiency" (Lebdai et al., 2020). Another study evaluated whether end of life (EOL) care simulations can improve undergraduate nursing students' knowledge, skill performance and self-confidence. The simulation group demonstrated a significant increase both immediately during the posttest and over time in EOL knowledge (p=0.000; p=0.000), skill performance (p=0.000; p=0.000) and self-confidence in EOL care (p=0.000) (Tamaki et al., 2019). The final

randomized control study evaluated the effectiveness of simulation-based deliberate practice on fostering undergraduate nursing students' communication, empathy, and self-efficacy skills. Students who participated in the stimulation training had a significant increase in their communication ability (p<.01), empathy, and self-efficacy scores (p=.003) (Li et al., 2019).

Anatomage as a Complementary tool

Two out of fourteen studies determined that the Anatomage table can be utilized as a complementary tool to enhance anatomy comprehension (Anand & Singel, 2017; Olowabi et al., 2022). In a comparative study directly comparing traditional dissection versus Anatomage dissection for neuroanatomy, 84% of students were in favor of including the Anatomage table as part of their regular curriculum (Anand & Singel, 2017). In a qualitative study gathering the expert opinion from African Anatomists, the most recurring opinion of the Anatomage table was the table complements the traditional cadaver-based approaches. Olowabi et al. (2022) argued that while the Anatomage table can be used as a supplementary teaching tool, it cannot replace real-life cadaver-based approaches. Although the Anatomage table may not be able to completely replace traditional dissection, many students' perception is that they benefited from its use and would like to use it as an additional learning resource.

Cadaver lab compared to Anatomage Table

Five out of fourteen studies directly compared student's learning with Anatomage table versus traditional dissection, however whether the results were statistically significant varied among the studies (Anand & Singel, 2017; Baratz et al., 2019; Bin Abdulrahman et al., 2021; Kausar et al., 2020; Washmuth et al., 2019). In a comparative study between Anatomage table and traditional dissection regarding neuroanatomy, there was no statistically significant difference between students who learned with one technique over the other (p=0.0979) (Anand &

Singel, 2017). A case study evaluated whether the Anatomage table would provide an equivalent educational opportunity for a pregnant student who could not participate in the usual cadaver labs (Washmuth et al., 2019). Every test the pregnant student took fell within the interquartile range of grades of the median values for the group that participated in cadaver dissection. The pregnant student's performance equally compared to the grades of the cadaver dissection group (Washmuth et al., 2019). Another study compared the Anatomage table versus cadaver dissection for two different topics: Pelvis and Perineum (P/P) or Musculoskeletal (MSK). There was no difference between the two modalities for P/P, but for the topic of MSK the Anatomage table had a significantly higher average quiz score on the post lab quiz (p=0.03) (Baratz et al., 2019). In a cross-sectional study, comparing the plastinated models with the Anatomage table demonstrated that there was a statistically significant difference between the mean scores for students who utilized both teaching modalities (p=0.0001) (Bin Abdulrahman et al., 2021). In a final cross-sectional study comparing lecture with a visualization table, there was no significant difference between the two methods of learning (p=0.24) (Kausar et al., 2020).

Improved Visualization of Structures

In four out of fourteen studies, students expressed that the Anatomage table helped improved visualization of various organ structures (Alasmari, 2021; Anand & Singel, 2017; Fyfe et al., 2018; Washmuth et al., 2019). In a comparative study that assessed virtual dissection against traditional dissection in neuroanatomy, 89% of students stated they could visualize relative size of different parts of the brain and spinal cord better (Anand & Singel, 2017). Additionally, 90% of students found the table helped them to visualize the spatial relationships of anatomical structures better (Anand & Singel, 2017). In a case study experiment, a pregnant student only used the Anatomage table rather than participating in cadaver dissection due to their

medical needs. The students said the table enabled them to examine the anatomy in unique ways, such as viewing cross-sections of various organs and visualizing structures from different vantage points (Washmuth et al., 2019). In a cohort study, surveying usefulness of the Anatomage table for a group of students in 2013 and 2014 found that in 2014, students rated the Anatomage table more favorable and determined it was helpful for understanding relative sizes of organs (Fyfe et al., 2018). In a cross-sectional descriptive study utilizing the Anatomage table as an additional tool, 90% of students found that the table's ability to rotate the digital body and dissect in 3-D helps in visualizing anatomical structures (Alasmari, 2021).

Theoretical Framework

The Academic Center for Evidence-Based Practice Star Model of Knowledge Transformation (ACE Star Model) was developed by Kathleen Stevens to understand all aspects of the evidenced-based practice processes including the cycles, nature, and characteristics of knowledge (White et al., 2015). The overarching goal is knowledge transformation, which can be defined as the conversion of research findings to impact health outcomes through evidence-based care (White et al., 2015). This model explains how knowledge can be transformed through discovery research, evidence summary, translation, integration, and evaluation (Appendix C). Additionally, it depicts the relationships between various stages of knowledge transformation, from newly discovered knowledge to best practice and outcomes (Melnyk & Fineout-Overholt, 2005).

The ACE Star Model emphasizes how systematic review and clinical practice guidelines can be used to implement research into practice. In the initial stages of this project, a literature review was conducted and compiled all relevant research regarding the effectiveness of the Anatomage table. Based on the literature review and recommendations found, the conductor of

the study created and implemented an action plan to educate students through use of the Anatomage table. Students then integrated their newfound knowledge into their clinical practice. Finally, student outcomes such as confidence level and knowledge of the material were evaluated. Through the execution of all five points of the ACE Star Model, this framework guided the implementation of the DNP project.

Project Aims and Objectives

Regional blocks are a frequently utilized method of providing anesthesia and reducing postoperative complications for patients. Students must have a thorough understanding of the anatomy involved and surrounding structures. The aim of this project is to determine whether the Anatomage table is effective in increasing student's knowledge and confidence levels regarding anatomy and completing the skill. Students completed a pretest prior to attending an educational session. During the educational session, the Anatomage table was used to teach SRNAs detailed information regarding landmarks and how to identify various anatomical structures for a neuraxial block. After the instructional session, students then completed a posttest. The predicted outcome was that students developed a more in-depth understanding of how to complete neuraxial blocks and their posttest results would improve significantly compared to their pretest results.

SWOT Analysis

Key stakeholders involved in this project include Student Registered Nurse Anesthetists (SRNAs) at Marian University. Other stakeholders include nursing graduate faculty, College of Osteopathic Medicine faculty, medical and biomedical students who all share use of the Anatomage table. This project was carried out in Indianapolis, Indiana. A SWOT table that summarizes the analysis can be found in Appendix D. Predicted strengths for this project include

that the university owns an Anatomage table that is available for use during the day. Additionally, students can access the table and freely utilize it as a supplemental tool. There are numerous instructional resources available that can elaborate on how to operate the digital table and employ its various features. Anticipated weaknesses were that there is only one Anatomage table available, so if the machine malfunctions or experiences a technical issue then the educational intervention cannot occur. A finite number of students can be hands on with the Anatomage table at a given time, so numerous small educational sessions needed to be held to accommodate all participants of the study. Implementation of this project gave students a more thorough educational experience regarding neuraxial blocks and a visual aid to enhance their understanding. Similarly, if students found utilization of the Anatomage table beneficial, current professors may begin to implement this device as an educational and supplemental tool. Foreseen threats include limited participation from SRNAs resulting in a small sample size. Also, students may have been knowledgeable regarding the table and regional blocks prior to the educational session and due to numerous sessions being held there was a potential for increased variability between individual sessions.

Project Design/Methods

The primary purpose of this project was to assess anesthesia students' knowledge of neuraxial anatomy and their confidence in performing a neuraxial block, along with the effectiveness of utilizing the Anatomage table in reinforcing the content. Within the literature review, various studies using the table had been completed, however there were no studies using the Anatomage table to teach central neuraxial blocks. This quality improvement design utilized an educational intervention in addition to a pretest-posttest format containing a variety of knowledge based quantitative questions, self-confidence questions and Likert scale questions.

These styles of questions were specifically chosen to mimic similar studies within the literature review (Anand & Singel, 2017; Baratz et al., 2019; Bin Abdulrahman et al., 2021; Boscolo-Berto et al., 2020; Fyfe et al., 2018; Kausar et al., 2020; Lebdai et al., 2020; Padilha et al., 2019; Tamaki et al., 2019).

Population and Setting

The project was conducted at a small, private university in central Indiana. The individuals participating in the project were SRNA students from the class of 2025 seeking an advanced nursing practice doctoral degree in anesthesia. This specific population was chosen because they had no previous education on neuraxial blocks or clinical experience. The population at hand had a wide array of ages ranging from their early 20s to greater than 50 and include all gender preferences. Inclusion criteria encompassed all graduate nursing students from the class of 2025 seeking a specialization in anesthesia. Exclusion criteria includes graduate nursing students seeking a specialization as a nurse practitioner and SRNA students from the class of 2024 and 2023.

The class and educational session were conducted in the university's simulation center. The conductor of the study worked closely with the simulation staff to gain access to the Anatomage table and prevent scheduling conflicts. During the project's implementation, the simulation lab was booked in advance to allow uninterrupted usage of the table during the educational intervention.

Barriers for implementation included difficulty scheduling time in the simulation lab, technology issues with the Anatomage table or accessing the quiz and having poor participation from the SRNA students. Solutions to those barriers included working with simulation staff in advance, practicing with the Anatomage table prior to implementation, having paper copies of

the survey available for those with technology issues, and communicating with the SRNAs in advance regarding their schedules and availability.

Measurement Instruments

The pretest and posttest questionnaire consisted of knowledge questions derived from the SRNA's curriculum, specifically utilizing Nurse Anesthesia, 6th ed. (Nagelhout & Elisha, 2018). The knowledge questionnaire was tested for content validity by experienced CRNAs well versed in neuraxial blocks (Appendix E). Additionally, a modified version of the National League for Nursing Student Satisfaction and Self-Confidence Tool (NLN, n.d.) was utilized to assess students' confidence in identifying anatomy and completing a neuraxial block in the clinical setting (Appendix F). The control group's questionnaire was identical to the intervention group's pretest.

Data Collection Procedures

Recruitment occurred through the prospective students' university email, along with scheduling information. A brief overview of the study, the Anatomage table and the benefits of participating in the project was shared with students. The pretest was also distributed in the recruitment email to ensure students' completion before attending the educational session. A quick-response (QR) code was made available for students to take the posttest immediately afterwards. A separate QR code was used for the control group's questionnaire. The pretest and posttest for participants were linked via the last four digits of the participants' student identification number (ID). The conductor did not have access to identify students based on their student ID. The password protected Qualtrics website was used to complete the survey and store the raw data. The raw data was not accessible by anyone other than the conductor. The data was only presented in aggregated form. A password protected excel spreadsheet was used to compare

and analyze the results of the raw data. The excel document will be stored on the conductor's password protected computer, and the data will be preserved for a maximum of two years then securely discarded.

Data Analysis

The efficacy of the project relies on data analysis. Data analysis provides a statistical measurement that ensures the effectiveness of a project (White et al., 2016). Nonparametric t-tests were chosen over parametric t-tests due to the study's small sample size (Nahm, 2016). A nonparametric paired t-test was used to compare pretest and posttest scores of students who participated in the entire study and determine the significance of the scores. A nonparametric independent t-test was also utilized to compare the posttest scores between students who participated and students who did not participate in the study.

Ethical Considerations/protection of human subjects

The Marian Internal Review Board (IRB) exemption (S23.151) was received on April 10, 2023, before the project's implementation. The IRB determination form can be found in Appendix G. Each participant used a unique ID number to maintain confidentiality of identifiable information and responses. There were no ethical concerns, or risk of physical or emotional injury to participants. Also, participants had the option to withdraw from the project at any point during the study.

Results

In line with the objective to assess the effectiveness of the Anatomage table in SRNA education, 28 first-year Marian SRNAs participated in this study to completion. 21 students participated in the intervention group by taking the pretest, attending the educational

intervention, and completing the posttest. Whereas the control group had 7 students who solely took the control assessment.

Knowledge and Self-Confidence with Current learning

The pretest for the intervention group and control test for the control group were identical. They consisted of 10 knowledge questions and 4 self-confidence questions. The posttest for the intervention group consisted of 10 knowledge questions, 2 satisfaction questions, 6 confidence questions and 2 Anatomage table opinion questions. All questions were analyzed separately by their reported levels of agreement and compared amongst groups. Please see Appendix H to view Tables 6-15.

Student Knowledge

Students were given a 10-question knowledge test on neuraxial anatomy. These were single-response multiple choice questions. Students in the intervention group took a knowledge test before and after the educational session. Their pretest scores ranged from 40 to 100%, with a mean of 61.9% (SD: 1.17). The intervention group's post-test scores ranged from 60 to 100%, with a mean score of 81.4% (SD: 0.91). A Wilcoxon Signed-Rank test concluded that the intervention group's posttest was statistically significant (p =.001) when compared to their pretest. The control group's knowledge test scores ranged from 60 to 90%, with a mean score of 72.9% (SD: 1.11). A Mann-Whitney U test concluded the control groups test scores were not statistically significant (U = 41, p = 0.073) when compared to the intervention group's posttest scores.

Intervention group Self-Confidence in Learning (Pre vs. Post-Test)

To determine self-confidence, students reported levels of personal satisfaction on a 5-point Likert scale that ranged from 1 to 5 (1= strongly disagree and 5= strongly agree). The

range of self-confidence mean scores for the pre-test was 2.62 to 3 (Table 1). The range of self-confidence mean scores for the post-test was 4.05 to 4.33. The results of a Wilcox Signed-Rank test concluded that the intervention group had more self-confidence in learning during the posttest than the pretest. Each individual question in the subscale was statistically significant (p=0.001). Additionally, the summative self-confidence score was higher in the posttest results (16.81) than the pretest (11.38). However, the difference in summed self-confidence was not statistically significant (p = 0.125).

Table 1

Intervention Group's Results of 4-Items to Measure Self-Confidence

Item	Intervention Group Pre-Test Mean (SD)	Intervention Group Post-Test Mean (SD)	Mean Difference	*p*-Value
Self-Confidence 5	3.00 (0.83)	4.24 (0.62)	+1.24	0.001
Self-Confidence 6	2.76 (0.83)	4.19 (0.60)	+1.43	0.001
Self-Confidence 7	3.00 (0.89)	4.33 (0.66)	+1.33	0.001
Self-Confidence 8	2.62 (0.81)	4.05 (0.87)	+1.43	0.001
Summed Confidence	11.38 (0.19)	16.81 (0.12)	+5.43	0.125

*Note. Using Wilcoxon Signed-Rank test, statistically significant change at p <0.05.

Both groups Self-Confidence in Learning (Control group vs. Intervention)

To determine self-confidence, students reported levels of personal satisfaction on a 5-point Likert scale that ranged from 1 to 5 (1= strongly disagree and 5= strongly agree). The self-confidence range of mean scores for the control group was 2.57 to 3.43 (Table 2). Whereas the self-confidence range of mean scores for the post-test was 4.05 to 4.33. The results of a Mann-Whitney U test concluded that the intervention group had more self-confidence in learning after the educational session compared to the control group. Each individual question in the subscale was statistically significant (p < .05). Additionally, the summative self-confidence score was higher in the intervention group's post-test (16.81) compared to the control group (11.38). The

difference in both groups' summed self-confidence was statistically significant (U= 0, p = 0.029).

Table 2

Both Groups' Results of 4-Items to Measure Self-Confidence

Item	Control Group Test Mean (SD)	Intervention Group Post-Test Mean (SD)	Mean Difference	*p*-Value
Self-Confidence 5	3.43 (0.79)	4.24 (0.62)	+0.81	0.020
Self-Confidence 6	3.00 (0.82)	4.19 (0.60)	+1.19	0.002
Self-Confidence 7	3.29 (0.76)	4.33 (0.66)	+1.05	0.005
Self-Confidence 8	2.57 (0.54)	4.05 (0.87)	+1.48	0.001
Summed Confidence	8.43 (0.38)	16.81 (0.12)	+8.38	0.029

**Note*. Using Mann-Whitney U test, statistically significant change at p <0.05.

Interventional Group Self-Confidence Descriptive Statistics

The interventional group's mean self-confidence scores for the pretest ranged between 2.62 to 3.00 (Table 3). With a median score of a 3 or "neither agree or disagree" in all items. Additionally, the range for all questions was between 1-4, with no students selecting a 5 or "strongly agree" in relation to confidence. On average, students did not feel confident or felt neutral regarding their knowledge and skill in placing neuraxial blocks prior to the intervention.

Table 3

Interventional Group's Self-Confidence Pretest Assessment Descriptive Statistics

Item	Mean	Std. Deviation	Median	Variance	Range
Self-Confidence 5	3.00	0.837	3	0.70	1-4
Self-Confidence 6	2.76	0.831	3	0.69	1-4
Self-Confidence 7	3.00	0.894	3	0.80	1-4
Self-Confidence 8	2.62	0.805	3	0.65	1-4

n=4

The interventional group's self-confidence posttest scores increased in all categories, showing a positive improvement after using the Anatomage table. Their mean scores ranged

from 4.048 to 4.857 (Table 4). This is a substantial improvement from their pre-test mean scores of 2.62 to 3.00. The median scores also increased from a 3 in all questions, to 4's and 5's. For self-confidence questions 1, 2, and 10, the range was 1-10. Only one student marked a 1 or "strongly disagree" for these questions. All other students marked 4 or 5 ("agree" or "strongly agree") (See Appendix H). The range also increased from 1-4 to 1-5 with more students choosing "strongly agree" for their confidence levels.

Table 4

Interventional Group's Self-Confidence Posttest Assessment Descriptive Statistics

Item	Mean	Std. Deviation	Median	Variance	Range
Self-Confidence 1	4.619	0.921	5	0.85	1-5
Self-Confidence 2	4.667	0.913	5	0.83	1-5
Self-Confidence 3	4.286	0.463	4	0.21	4-5
Self-Confidence 4	4.762	0.436	5	0.19	4-5
Self-Confidence 5	4.238	0.625	4	0.39	3-5
Self-Confidence 6	4.190	0.602	4	0.36	3-5
Self-Confidence 7	4.333	0.658	4	0.43	3-5
Self-Confidence 8	4.048	0.865	4	0.75	2-5
Self-Confidence 9	4.857	0.359	5	0.13	4-5
Self-Confidence 10	4.667	0.913	5	0.83	1-5

n=21

Control Group Self-Confidence Descriptive Statistics

The control group's mean and median scores were comparable to the interventional group's pre-test scores. The control group's mean scores ranged from 2.57 to 3.43 (Table 5). Their median scores were mostly 3's ("neither disagree or agree") and a 4 ("agree"). The range varied anywhere between 2-3 and 2-4. With no students marking a 1 ("strongly disagree") or 5 ("strongly agree") regarding their confidence levels. However, the control group's self-confidence means and median scores were noticeably lower than the interventional group's post-test scores, which had mean scores ranging from 4.048 to 4.857 and median scores in the 4's and 5's ("agree" or "strongly agree").

Table 5

Control Group's Self-Confidence Assessment Descriptive Statistics

Item	Mean	Std. Deviation	Median	Variance	Range
Self-Confidence 5	3.43	0.787	4	0.62	2-4
Self-Confidence 6	3.00	0.816	3	0.67	2-4
Self-Confidence 7	3.29	0.756	3	0.57	2-4
Self-Confidence 8	2.57	0.535	3	0.29	2-3

n=7

Discussion of Findings

Our findings of increased knowledge and satisfaction align with Baratz et al. (2019), Anand & Singel (2017), and Fyfe et al. (2018), who also noted enhanced learning outcomes with similar digital tools. The SRNAs that took part in the experimental group had improved knowledge and satisfaction with learning methods compared to the control group. 80.95% of participants "strongly agree" and 14.29% "agree" the Anatomage table should be incorporated into the SRNA curriculum. Similarly, 76.19% of participants "strongly agree" and 19.05% "agree" the Anatomage table was motivating and helped them learn. One student did skew the data since they marked these questions as a "1" or "strongly disagree" but it is possible the student answered the questions without reading the scale correctly. Additionally, 100% of participants felt that the Anatomage table was a helpful tool, with 85.71% of participants marking "strongly agree" and 14.29% marking "agree". Overall students felt strongly that the Anatomage table is a great resource to utilize in the CRNA program.

The control group had a high average score on the knowledge test. They also had some high scores on the confidence scores but not as high as the interventional post-group since none of the students marked a 5 or "strongly agree" for the confidence levels. This could be due to their data being collected one week after the intervention group took part in the study. The project was implemented the same week as the students' Anesthesia Principle's neuraxial

lectures. Since the control group already had been exposed to the class material for a week longer than the intervention group, it is possible that they may have already spent time learning some of the material. Additionally, increased exposure to the material may have improved their knowledge and self-confidence. However, the control group did not feel as if they had mastered the steps to perform a spinal with 57.14% of participants marking “neither agree or disagree” and 42.86% marking “disagree.”

To conclude, students who attended the educational intervention with the Anatomage table had higher level of knowledge and self-confidence compared to students who did not attend. Additionally, students felt like the Anatomage table was useful in enhancing their understanding of neuraxial anatomy and blocks and would like the Anatomage table to be incorporated into the curriculum.

Strengths and Limitations

Some of the strengths of this project were the Anatomage table was readily available and numerous resources were accessible for the investigator to learn how to operate the table. Due to the project's nature, resource availability and lack of monetary requirement, this project would be easy to replicate or build upon as a legacy project. Additionally, the project was intentionally implemented the same week as the student’s neuraxial lecture to serve as a supplementation of material and encourage student participation.

A limitation of this project was the small sample size. Only first-year Marian SRNA students were enlisted to take part due to convenience, lack of access to students from other programs, and their limited knowledge surrounding the topic at hand. Due to the specificity of the population, the data results cannot be generalized to SRNAs at other institutions. Additionally, due to the small sample size, only non-parametric statistics could be calculated.

Finally, there may be an increased variability of effectiveness due to many sessions being held and slight variations in the educational session due to it not being completely scripted. While the results are promising, they should be interpreted with caution due to the small sample size and the potential influence of coinciding lectures.

Conclusion

The results of the study demonstrated that the Anatomage table significantly improves knowledge and self-confidence among first-year Marian SRNAs in neuraxial block techniques. Additionally, students agreed the use of the Anatomage table was a beneficial and helpful tool for enhancing their understanding of neuraxial blocks. This study contributes to our understanding of how innovative educational technologies can be effectively integrated into specialized nursing programs. However, more research is needed to assess the long-term effects of digital tools like the Anatomage table on SRNA education across diverse educational settings. In conclusion, these findings suggest the benefit of integrating advanced digital tools in nursing education curricula to improve learning outcomes and subsequently enhance patient care.

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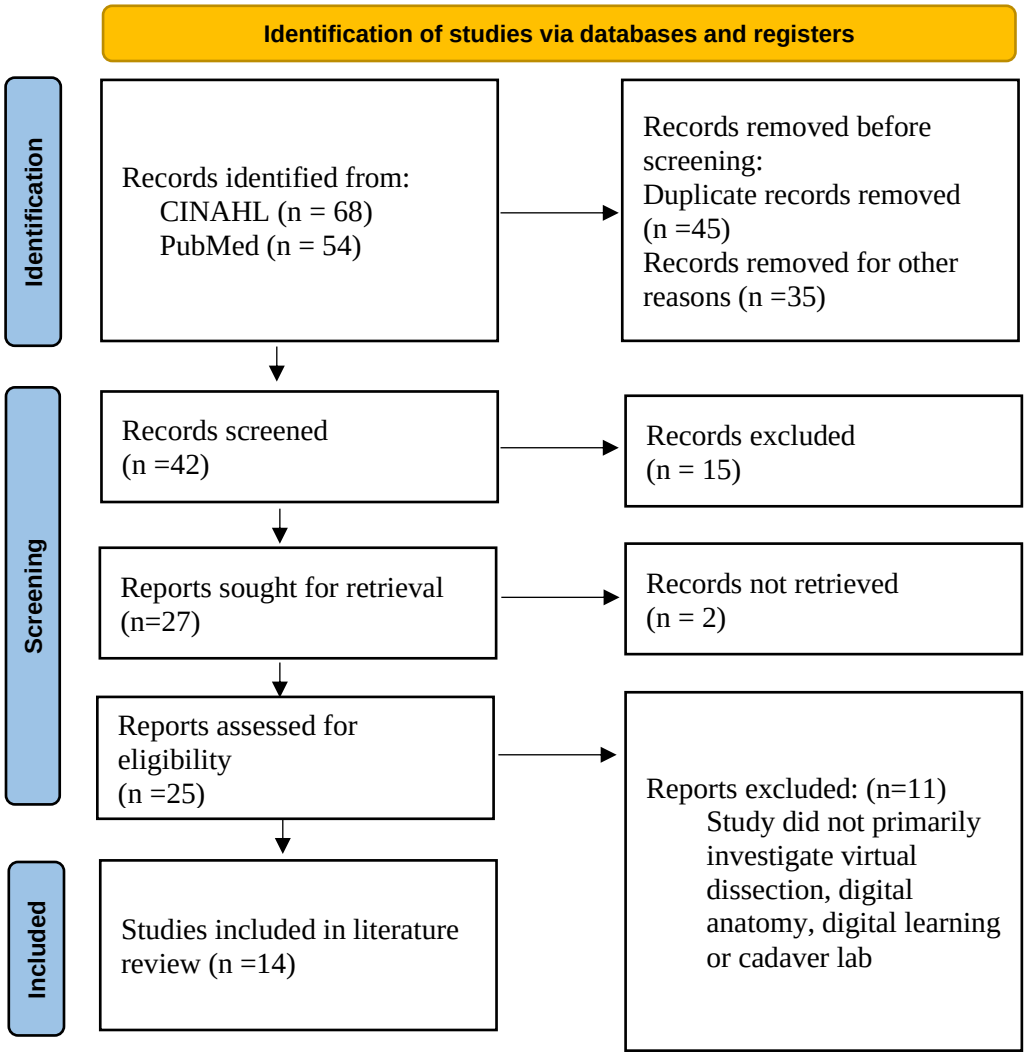
Appendix A

Prisma Flow Diagram



From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71. doi: 10.1136/bmj.n71 For more information, visit: http://www.prisma-statement.org/

Appendix B

Literature Review Matrix

Citation	Research Design & Level of Evidence	Population / Sample size n=x	Major Variables	Instruments / Data collection	Results
(Alasmari, 2021)	Cross-sectional descriptive Study, Level VI	Medical students in the Department of Anatomy at College of Medicine, Umm Al-Qura University; N=78	Independent: Anatomage table	Electronic questionnaire with 6 questions	81% of the students preferred using 3-D Anatomage as an additional tool to cadaveric dissected specimens in learning anatomy. 90% of the participating students believed that Anatomage helps in visualizing the body system due to the ability to rotate the digital body and accordingly provided a better understanding of Anatomy.
(Anand & Singel, 2017)	Randomized cross sectional prospective study, Level IV	1st year MBBS class of Gujarat Adani Institute of Medical Sciences; n=122	Independent: Anatomage virtual dissection table, direct exposure to specimens and performed dissection	Pretest and posttest with 20 single correct answer type Multiple Choice Questions. Likert's 5-point scale	There was no statistically significant difference found between learning with the "Anatomage" table compared to learning with traditional dissection (p=0.0979). 51% of Students agreed that the virtual dissection table helped them to understand the topic better. 90% found it helped them to visualize relations of different parts better. 79% agreed it enhanced their learning experience
(Baratz et al., 2019)	Randomized Cross-sectional study, Level III	First-year medical student volunteers who had previously dissected thorax and abdomen; N=16	Independent: Anatomage table, cadaveric dissection Dependent: Pelvis/perineum and musculoskeletal system	Likert scale surveys before and affect each scheduled dissection session and a 5-question multiple choice post-lab quiz	No difference was found between the two modalities in pelvis/perineum. In MSK, the Anatomage group had a significantly higher average quiz score than the control group (p=0.03). The pre- and post-lab qualitative surveys indicated that students who learned via the Anatomage table were more excited both before and after the labs and believed they learned more.

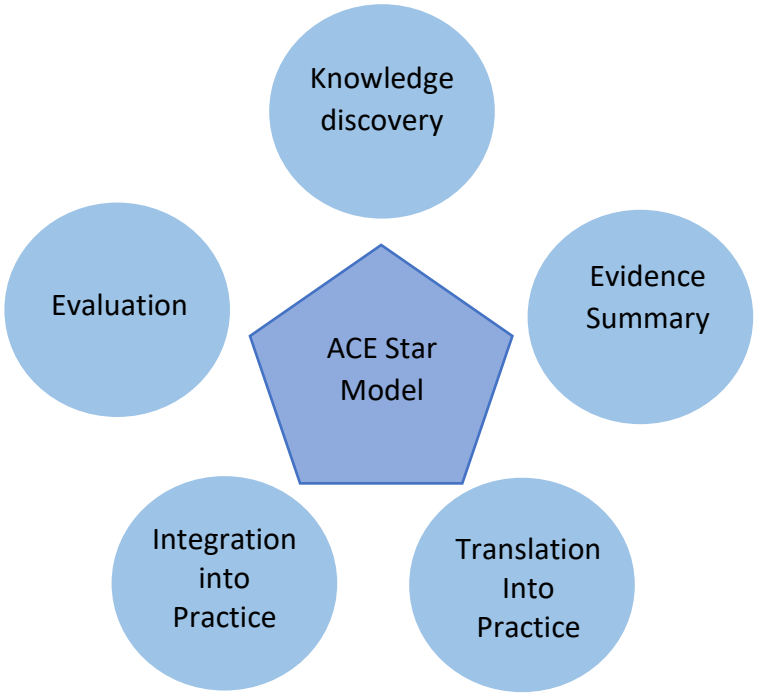
(Bin Abdulrahman et al., 2021)	Randomized Cross-sectional study, Level II	First year college of medicine at Imam Mohammad Ibn Saud Islamic University N=211	Independent: Anatomage table, Plastinated specimens, both	Objective structed practical examination with ten practical questions Structured questionnaire with 15 Likert-type scale questions	The combined method was significantly different from other methods. No significant difference between Anatomage and plastinated models Higher and positive students' attitudes in favor of both models teaching compared to Anatomage table and plastinated model teaching alone
(Boscolo-Berto et al., 2020)	Randomized controlled trial, Level II	Second year medical students who took part in the elective anatomic dissection course; N=23	Independent: Textbook consultation, virtual dissection	Pre-test with 10 multiple choice questions Posttest with four questions	Better overall test performance was detected for the group that participated in virtual dissection (p=0.06) Medical students who participated in virtual dissection were over 3 times more likely to report a positive outcome at the post-dissection test
(Fyfe et al., 2018)	Prospective Cohort, Level IV	First year human biology students at Curtin University 2013 n = 333 2-14 n = 329	Dependent: use of a smart phone, tablet, anatomy apps	Survey with Likert scales, rating scales, text responses, and radio buttons	Significant increase in the average rating for the usefulness of the Anatomage table (p=0.022). In 2014, respondents rated the Anatomage table more favorably than in 2013 (p=0.022) Rated most helpful for understanding relative sizes of organs but least helpful for using correct anatomical terminology
(Kausar et al., 2020)	Randomized Cross-sectional study, Level II	First year Bachelor of Dental Surgery Students; n=50	Independent: traditional lecture, Sectra visualization table	Multiple choice question test with 10 questions Likert scale	Statistically non-significance between the two groups (p=0.24) All students showed strong positive response towards the use of Sectra For 7/10 questions, more than 60% expressed strong agreement
(Lebdai et al., 2020)	Prospective randomized controlled study, Level II	Fourth Year Angers School of Medicine Semester 1 (n=38) Semester 2 (n=47)	Independent: Immersive Virtual Patient Simulation group trained on 3 different virtual clinical cases	Standard posttest which included a clinical case with multiple choice questions and 5-point Likert scale	Students from the IVPS group achieved significantly higher grades in semester 2 than in semester 1($p = 0.0020$. Students from the IVPS group in both semesters 1 and 2 achieved significantly higher grades than either of the control groups from semesters 1 and 2 ($p < 0.003$).
(Li et al., 2019).	Randomized controlled trial, Level II	First year undergraduate students (n=132)	Independent: Simulation-based deliberate practice	The Communication Skills Assessment Scale, the Jefferson Scale of Empathy-Health	Based off the clinical communication ability scale scores, there were remarkable improve-

			which included educational videos and discussions, scenario-based simulations, reflections on their communication skills and empathy ability and a group chat to share communication videos, skills, and knowledge.	Professionals, and the General Self-Efficacy Scale.	ments in the experimental group, with a statistically significant difference ($p < .01$). During the posttest, students' empathy scores had noteworthy improvements in the experimental group, with a statistically significant difference. Students' self-efficacy scores significantly improved in the posttest of the experimental group ($p = .003$).
(Owolabi et al., 2022)	Qualitative Study, Level VI	Anatomy teachers from 11 African Countries. N=79	Dependent: Anatomage-user institution, non-user institution	Focused Group Discussion guided questions; In-depth Interview guided questions	Most recurring opinion was the Anatomage table could only be a "complementary teaching tool to cadavers", it "can't replace real-life experience with cadavers." "Supplement for cadaveric dissection, not a substitute." Has "potential to integrate both laboratory and classroom experience." "Solve shortages of a cadaver."
(Padilha et al., 2019)	Randomized controlled trail, Level II	Second year Portuguese nursing students (N=42)	Independent: clinical virtual simulator Dependent: Knowledge and clinical reasoning	Pretest and 2 posttests (one after the intervention, and one 2 months later) Knowledge assessments with T/F questions and multiple-choice, 10-point Likert scale for satisfaction levels, 5-point Likert scale for self-efficacy	Students who participated in the clinical virtual simulation had statistically significant differences in knowledge retention after the intervention (p=.001), knowledge retention 2 months later (p=.02), and in learning satisfaction (p<.001). These students also presented with better outcomes in knowledge retention and learning satisfaction than students who did not participate in the clinical virtual simulation.
(Tamaki et al., 2019)	Randomized controlled study, Level II	Third year Japanese nursing students (n=38)	Independent: End of Life care simulation	Pre and Post test Knowledge questionnaire with 10 multiple-choice questions Objective Structured Clinical Evaluation with a physical assessment examination station	In the post-test, the mean knowledge score had significantly increased for the simulation group (p=0.000). The mean physical assessment score of the simulation group had significantly increased (p=0.000) at the post-test.

				and a psychological care examination to evaluate skill performance.	The mean score for psychological care was also significantly greater (p=0.000) at the post-test in the simulation group.
(Tirelli et al., 2021)	Blind prospective study on a retrospective cohort, Level IV	Head and neck squamous cell carcinoma treated in their department between 2012 and 2018 N=66	Dependent: lymph nodal metastases, size of the lymph nodes	Radiologist reviewed the reconstructions blinded to lymph node size and pENE status, also asked to express a judgment as to whether capsular involvement was present, results compared with the CT, MRI, and histology reports to determine accuracy of Anatomage table.	For lymph nodes > 15 mm on CT, Anatomage table 3-D reconstructions identified extracapsular invasion with a sensitivity of 100%, a specificity of 75%, a positive predictive value of 86%, and a negative predictive value of 100%. The Anatomage table enabled detection of all 30 patients who were pENE+. Had a higher percentage of concordance with histopathological examination (90%) than the CT and MRI scans
(Washmuth et al., 2019)	Case Study design, Level IV	Graduate Nurse anesthesia students (one who is pregnant) N=25	Independent: cadaver dissection, Anatomage table	Four written and four practical exams Also, open-ended qualitative data	The Anatomage table grades are the same or higher than the cadaver dissection group median values for 3 exams and lower on one exam. In every test, the Anatomage table grade falls within the Interquartile range

Appendix C

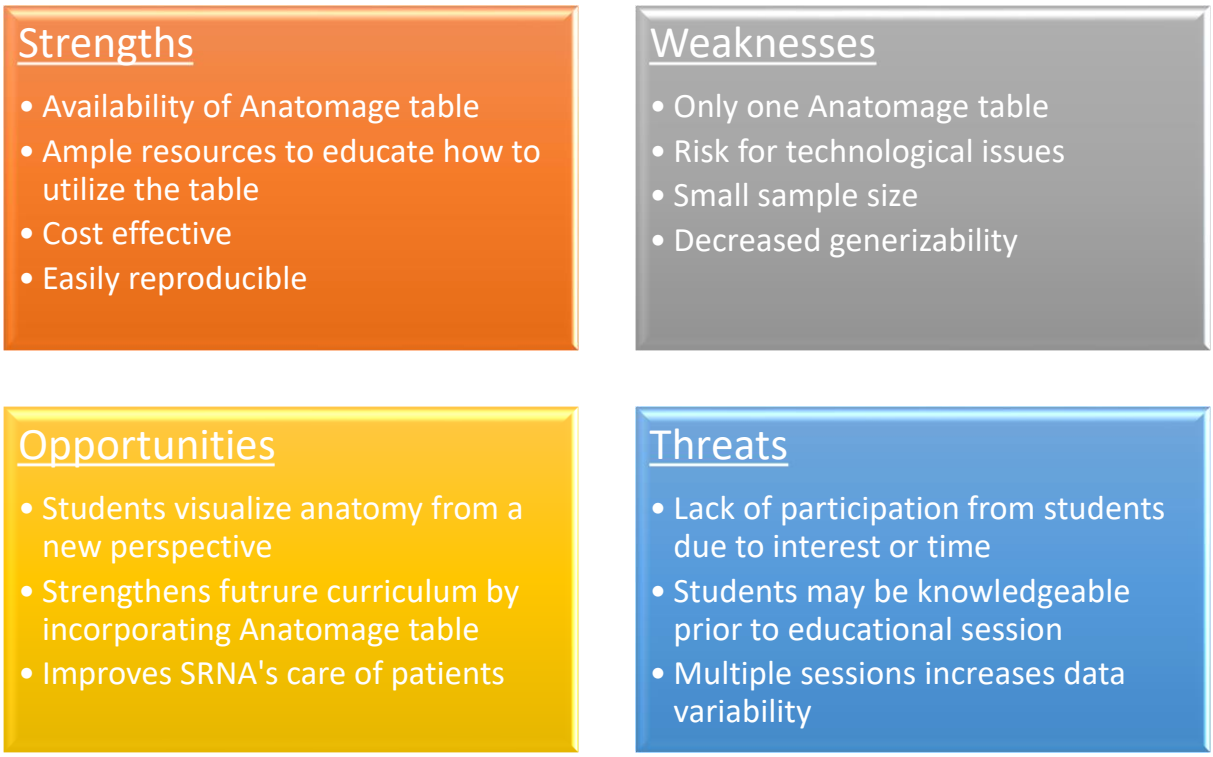
The Academic Center for Evidence-Based Practice Star Model of Knowledge Transformation



White, K. M., Dudley-Brown, S., & Terhaar, M. F. (Eds.). (2015). *Translation of evidence into nursing and health care, second edition*. Springer Publishing Company, Incorporated.

Appendix D

SWOT Analysis



Appendix E

Knowledge Assessment Questionnaire

1. The spinal cord ends at what level in an adult?
    a. L2
    b. S1
    c. L3
    d. T10
2. What vertebral level does the intercristal line correlate with?
    a. L2
    b. T12
    c. L4
    d. C6
3. Which components of the spinal cord are associated with kyphosis?
    a. Cervical
    b. Thoracic
    c. Lumbar
    d. Cranial
4. What is the average distance from the skin to the lumbar epidural space when using a midline approach?
    a. 5 mm
    b. 2 cm
    c. 5 cm
    d. 7 cm
5. When placing a traditional midline neuraxial anesthetic, which is the correct order of structures that are pierced with the needle?
    a. Skin -> Anterior Longitudinal Ligament -> Interspinous ligament -> Posterior Longitudinal Ligament
    b. Skin -> Ligamentum Flavum -> Anterior Longitudinal Ligament -> Interspinous ligament
    c. Skin -> Interspinous ligament -> Supraspinous Ligament -> Posterior Longitudinal Ligament
    d. Skin-> Supraspinous Ligament -> Interspinous Ligament -> Ligamentum Flavum
6. Where are spinal blocks administered?
    a. Epidural Space
    b. Subdural Space
    c. Epiarachnoid Space
    d. Subarachnoid Space
7. Cervical and thoracic vertebrae have spinous processes that are angled in a caudal direction.
    a. True

   b. False
8. As the pencil-point needle tip passes through the _____, the CRNA may feel a “pop” or “click” sensation.
   a. Dura Mater
   b. Arachnoid Mater
   c. Pia Mater
   d. Ligamentum Flavum
9. Approximately how much cerebrospinal fluid is present in the spinal canal?
   a. 15-30 mLs
   b. 30-80 mLs
   c. 90-120 mLs
   d. 100-150 mLs
10. Which ligament is located in between the lamina of the vertebrae?
   a. Supraspinous Ligament
   b. Interspinous Ligament
   c. Ligamentum Flavum
   d. Posterior longitudinal Ligament

Appendix F

Student Satisfaction and Self-confidence assessment for the Pretest and Control test

	Strongly Disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
I am confident that I am developing the skills and obtaining the required knowledge to perform neuraxial blocks in a clinical setting.	○	○	○	○	○
I am confident in my knowledge regarding neuraxial anatomy.	○	○	○	○	○
I am confident that I can identify pertinent anatomical landmarks on a patient.	○	○	○	○	○
I am confident that I have an overall mastery of the steps involved in performing a spinal block.	○	○	○	○	○

Student Satisfaction and Self-confidence assessment for the Posttest

	Strongly Disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
The teaching methods used in this simulation were helpful and effective.	○	○	○	○	○
The Anatomage table used in this simulation were motivating and helped me to learn.	○	○	○	○	○
I think the anatomage table should be incorporated into the SRNA curriculum.	○	○	○	○	○
I am confident that I am mastering the content of the simulation activity that my instructor presented to me.	○	○	○	○	○
I am confident that this simulation covered critical content necessary for the mastery of neuraxial blocks.	○	○	○	○	○
I am confident that I am developing the skills and obtaining the required knowledge to perform neuraxial blocks in a clinical setting.	○	○	○	○	○
The Anatomage table was a helpful resource to teach the simulation.	○	○	○	○	○
I am confident in my knowledge regarding neuraxial anatomy.	○	○	○	○	○
I am confident that I can identify pertinent anatomical landmarks on a patient.	○	○	○	○	○
I am confident that I have an overall mastery of the steps involved in performing a spinal block.	○	○	○	○	○

Appendix G

MARIAN UNIVERSITY
Indianapolis ®

Institutional Review Board

DATE:	04-10-2023
TO:	Sarah Johnson & Dr. Marie Goez
FROM:	Institutional Review Board
RE:	S23.151
TITLE:	Effectiveness of Utilizing the Anatomage Table to Teach a Neuraxial Block
SUBMISSION TYPE:	New Project
ACTION:	Determination of EXEMPT Status
DECISION DATE:	04-10-2023

The Institutional Review Board at Marian University has reviewed your protocol and has determined the procedures proposed are appropriate for exemption under the federal regulation. As such, there will be no further review of your protocol and you are cleared to proceed with your project. The protocol will remain on file with the Marian University IRB as a matter of record.

Although researchers for exempt studies are not required to complete online CITI training for research involving human subjects, the IRB **recommends** that they do so, particularly as a learning exercise in the case of student researchers. Information on CITI training can be found on the IRB's website: http://www.marian.edu/academics/institutional-review-board.

It is the responsibility of the PI (and, if applicable, the faculty supervisor) to inform the IRB if the procedures presented in this protocol are to be modified of if problems related to human research participants arise in connection with this project. Any procedural modifications must be evaluated by the IRB before being implemented, as some modifications may change the review status of this project. Please contact me if you are unsure whether your proposed modification requires review. Proposed modifications should be addressed in writing to the IRB. **Please reference the above IRB protocol number in any communication to the IRB regarding this project.**

Amanda C. Egan, Ph.D.
Chair, Marian University Institutional Review Board

Appendix H

Table 6

Helpfulness of Teaching Methods Used in Simulation

Helpfulness of Teaching Methods Used	n	%
Post-Test Experimental Group		
Strongly Disagree	1	4.76
Disagree	0	0.00
Undecided	0	0.00
Agree	4	19.05
Strongly Agree	16	76.19

Table 7

Anatomage table used in this simulation were motivating and helped me to learn

Motivating and Helpful	n	%
Post-Test Experimental Group		
Strongly Disagree	1	4.76
Disagree	0	0.00
Undecided	0	0.00
Agree	4	19.05
Strongly Agree	16	76.19

Table 8

Confidence in Mastering the Content of the Simulation Activity

Confidence in Mastering the Content	n	%
Post-Test Experimental Group		
Strongly Disagree	0	0.00
Disagree	0	0.00
Undecided	0	0.00
Agree	15	71.43
Strongly Agree	6	28.57

Table 9

Confidence that this simulation covered critical content necessary for the mastery of neuraxial blocks.

Confidence that this simulation covered critical content	n	%
Post-Test Experimental Group		
Strongly Disagree	0	0.00
Disagree	0	0.00
Undecided	0	0.00
Agree	5	23.81
Strongly Agree	16	76.19

Table 10

Confidence in developing the skills and obtaining the required knowledge to perform neuraxial blocks in a clinical setting

Confidence in Developing skills and Obtaining Knowledge	n	%
Pre-Test Experimental Group		
Strongly Disagree	1	4.76
Disagree	4	19.05
Undecided	10	47.62
Agree	6	28.57
Strongly Agree	0	0.00
Post-Test Experimental Group		
Strongly Disagree	0	0.00
Disagree	0	0.00
Undecided	2	9.52
Agree	12	57.14
Strongly Agree	7	33.33
Control Group		
Strongly Disagree	0	0.00
Disagree	1	14.29
Undecided	2	28.57
Agree	4	57.14
Strongly Agree	0	0.00

Table 11

Confidence in Knowledge

Confidence in Knowledge	n	%
Pre-Test Experimental Group		
Strongly Disagree	1	4.76
Disagree	7	33.33

Undecided	9	42.86
Agree	4	19.05
Strongly Agree	0	0.00
Post-Test Experimental Group		
Strongly Disagree	0	0.00
Disagree	0	0.00
Undecided	2	9.52
Agree	13	61.9
Strongly Agree	6	28.6
Control Group		
Strongly Disagree	0	0.00
Disagree	2	28.57
Undecided	3	42.86
Agree	2	28.57
Strongly Agree	0	0.00

Table 12

Confidence in identifying pertinent anatomical landmarks

Confidence in identifying landmarks	n	%
Pre-Test Experimental Group		
Strongly Disagree	1	4.76
Disagree	5	23.81
Undecided	8	38.10
Agree	7	33.33
Strongly Agree	0	0.00
Post-Test Experimental Group		
Strongly Disagree	0	0.00
Disagree	0	0.00
Undecided	2	9.52
Agree	10	47.62
Strongly Agree	9	42.86
Control Group		
Strongly Disagree	0	0.00
Disagree	1	14.29
Undecided	3	42.86
Agree	3	42.86
Strongly Agree	0	0.00

Table 13

Confidence in mastery of steps to perform a spinal

Confidence in mastery of steps to perform a spinal	n	%
Pre-Test Experimental Group		
Strongly Disagree	1	4.76
Disagree	9	42.86
Undecided	8	38.10
Agree	3	14.29
Strongly Agree	0	0.00
Post-Test Experimental Group		
Strongly Disagree	0	0.00
Disagree	1	4.76
Undecided	4	19.05
Agree	9	42.86
Strongly Agree	7	33.33
Control Group		
Strongly Disagree	0	0.00
Disagree	3	42.86
Undecided	4	57.14
Agree	0	0.00
Strongly Agree	0	0.00

Table 14

Anatomage table was a helpful resource

Anatomage table was a helpful resource	n	%
Post-Test Experimental Group		
Strongly Disagree	0	0.00
Disagree	0	0.00
Undecided	0	0.00
Agree	3	14.29
Strongly Agree	18	85.71

Table 15

Anatomage table should be incorporated into curriculum

Anatomage table should be incorporated into curriculum	n	%
Post-Test Experimental Group		

Strongly Disagree	1	4.76
Disagree	0	0.00
Undecided	0	0.00
Agree	3	14.29
Strongly Agree	17	80.95