Marian University

Leighton School of Nursing

Doctor of Nursing Practice

Final Project Report for Students graduating in May 2023

Anatomage Table and Effects on Improving Clinical Anatomy Knowledge and Competence in Anesthesia Procedures and Assessment

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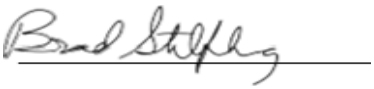

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Abstract

Background The Certified Registered Nurse Anesthetist (CRNA) profession is fast growing and at an all-time high, with over 56 thousand licensed professionals. Nurse Anesthetist programs are tasked with developing a high academic curriculum with a strong anatomy course at its core. In a hospital setting, CRNAs are considered the airway experts that respond to airway emergencies, called to perform Transesophageal Echocardiograms (TEEs), Point of Care Ultrasounds (POCUs) including high risk procedures such as Peripheral Nerve Blocks (PNB), spinals and epidurals. Hence, a sound working knowledge of anatomical structures and their relationship to surrounding structures is vital. To bridge the gap in knowledge and comprehension of anatomy, several curriculums are starting to employ the use of virtual reality or 3D technology as an adjunct to learning anatomy. The Anatomage Table (AT) is the first 3D virtual dissection table that allows users to visualize anatomy at the highest level of accuracy. The AT is a fairly new technology developed in 2004 with limited research published to address its usefulness in graduate/undergraduate nursing programs. No research was found that evaluates the effectiveness and impact of the AT in learning anatomy in the Nurse Anesthesia Program.

Purpose: The purpose of this project is to evaluate the effectiveness and perceived benefits of the AT to improve the knowledge of clinical anatomy and enhance performance of point-of-care assessments and interventional anesthesia procedures in first year student registered nurse anesthetists (SRNA) during the 2021-2022 academic year.

Methods: This was a two-part project, a sequential explanatory mixed methods design. Quantitative and qualitative data were evaluated using a pre and post-test, a self-efficacy tool, an open-ended questionnaire, and a PNB simulation exam.

Utilizing prebriefing video teaching airway anatomy and its innervations was published for students to view prior to attending a hands-on simulation. A pretest was given prior to the simulation experience followed by a posttest, a self-efficacy survey and an open-ended questionnaire. Subsequently, the AT was used as an adjunct to teach interscalene block prior to their PNB simulation exam. The previous cohort who received teaching using traditional methods (lecture, mannikin, cadaver) was used as a comparison group.

Results: Mean knowledge scores increased from 9.40 ± 2.46 in the pretest to 10.56 ± 2.42 in the posttest (p=.052). $p>0.05$. However, students reported the AT as an effective teaching tool that enhanced their knowledge of anatomy, increased retention, and had a positive impact on clinical preparedness.

Keywords: Virtual reality, Anatomy [Education], Anatomage, 3D Visualization, 3-dimensional education, three-dimensional image, or imaging,

Anatomage Table and Effects on Improving Clinical Anatomy Knowledge and Competence in Anesthesia Procedures and Assessment

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, Nurse Anesthesia track. Integrating 3D Anatomage Table into the nurse anesthesia curriculum shows promise to increase knowledge of clinical anatomy. A sound working knowledge of anatomy gained from Anatomage training will enhance the Students Registered Nurse Anesthetist (SRNA) performance of peripheral nerve blocks (PNBs), emergency cricothyroidotomy, and assessment of cranial nerve (CN) function during and after surgery. This DNP project seeks to assess students' level of anatomy knowledge and competence gained from Anatomage training modules and live sessions on PNBs, laryngeal anatomy, and CN innervations.

Performing a PNB involves the infiltration of local nerves that innervates a body region to be operated on with local anesthetics which then inhibits peripheral nerves from communicating with the central nervous system, thereby allowing the surgical procedure to take place without the patient feeling any pain (Héroux et al., 2019). The use of PNBs to facilitate surgical procedures is on the rise and presents tremendous benefits to patients in improving outcome and functional recovery. A significant 20% of upper extremity surgeries are carried out solely under PNBs while still rendering the body region immobile and/or painless, therefore eliminating the side effects of general anesthesia (Héroux et al., 2019). Side effects of general anesthesia include nausea and vomiting, sore throat, fatigue, and prolonged hospital stay (Héroux et al., 2019). According to Héroux et al. (2019) it has been established that the use of PNBs among the elderly population poses a greater advantage because studies have shown that it decreases the incidences of postoperative delirium that is otherwise rampant from the use of anesthetic agents.

Through technological advances neurologic injuries following PNB are rare (5 in every 10,000) with most being transient, PNBs is not without risk, hence devastating, and long-lasting complications could occur (Terracciano et al., 2019). The type of block and breaking the skin barrier with a needle places patients at risk for bleeding, infection, neuropathy, and damage to neighboring structures (Terracciano et al., 2019). Mechanical trauma from needle placements can be avoided through an in-depth knowledge of anatomy and anatomical variations in various populations. An advance knowledge of anatomy can be facilitated through the incorporation of the Anatomage Table in preparing SRNA's for clinical practice. Cadaver dissection has been the traditional teaching method for learning human anatomy, however, studies show enhanced learning experiences with the incorporation of 3D technology such as the Anatomage table. In a study conducted by Alasmari (2021), students preferred using 3D Anatomage as an adjunct tool to cadaver dissection in learning anatomy as it fostered interactive learning (Alasmari, 2021). Reports have shown that 89% of students agree that 3D Anatomage was instrumental to their understanding of the relationship between internal structures and visualizing the body system (Alasmari, 2021).

Background

Anatomy is the basis of all medical education. It is the fundamental basic knowledge to which healthcare providers build a solid background for clinical practice (Saverino, 2020). The practice of regional anesthesia such as PNBs particularly is inconceivable without a sound knowledge of the human anatomy. Hewson et al., (2018) highlighted a review article that reported that post-operative neurological symptoms suggestive of nerve injury after PNBs among anesthesiologist occur in 0-2.2% of patient in 3 months, 0-0.8% of patients in 6 months and 0--.2% of patient in 1 year. Several factors including nerve localization technique contribute to the

likelihood of nerve injury following a PNBs. The importance of a detailed knowledge of human anatomy in anesthesia education to ensure safe medical practices cannot be over emphasized. Trauma to the airway significantly contributes to patient morbidity and mortality. Moreover, airway injury constitutes 6% of the most common injuries leading to malpractice claims (Patwa & Shah, 2015). A sound knowledge of airway anatomy improves safety of the conduct of anesthesia, optimizes ventilation and airway patency (Patwa & Shah, 2015).

Traditionally cadaver-based anatomical education has been the gold standard for hundreds of years. However, in recent years medical teaching institutions have looked to other modalities to enhance anatomy education due to limitations such as scarcity of cadavers, increasing costs in acquisition, maintenance, and time-consuming dissection-based instruction (Singal et al., 2020). Considering the covid 19 pandemic aftermath, cadavers are projected to become an even more rare commodity as body donors may be carriers or would have died of covid 19 and currently, no screening tests exist to rule out this infection in donors (Singal et al., 2020). Therefore, it is not advisable to accept body donations for the safety of students and faculty (Singal et al., 2020).

Moreover, students have reported inadequate exposure to anatomy during clinical training, such that there is a growing concern that medical students are not competent in anatomy knowledge when they enter clinical practice (Ghosh, 2017). While human cadaveric based instruction is the preferred pedagogy, students still express varied reactions to this method, presenting with differing levels of anatomy self-efficacy (Langfield et al., 2018). Although no single teaching tool has been found to meet all curriculum requirements, the multimodal approach has been advocated as the best way to teach modern anatomy (Estai & Bunt, 2016). Integrating 3D visualization technologies in anatomy education is one of the ways being explored to this effect.

Integrating 3D interactive visual technology such as the use of an Anatomage Table into the existing anesthesia program curriculum at Marian University may Anatomage Table is an advanced 3D visualization system that allows students to interact with digital cadavers for anatomy and physiology education. This DNP project will develop, pilot, and evaluate the perceived benefits of Anatomage Table incorporated into the current anesthesia education at Marian University.

Problem Statement

Lack of confidence in performing peripheral nerve blocks, and low levels of anatomy self-efficacy can lead to unsafe practice that may lead to dangerous patient adverse outcomes. In the past Marian SRNAs have relied on pictorial images from textbooks, YouTube videos, and anatomy apps to enhance classroom anatomy education. The growing evidence that anatomical understanding can be enhanced with the use of 3D resources along with the positive outcomes of evidence based multimodal approaches to anatomy education, has led to a new approach in the curriculum resulting in the acquisition of an Anatomage Table. Does the use of an AnatomageTable increase knowledge of clinical anatomy and enhance performance of regional anesthesia procedures in CRNA students compared to current practice?

Needs Assessment and Gap Analysis

The CRNA program at Marian University currently utilizes traditional teaching modalities for anatomy and physiology learning. Current modalities of teaching include textbooks, research papers, videos, anatomy applications, simulation, and lectures. Current evidence identifies the Anatomage Table as beneficial in improving students' understanding of human anatomy and showcases anatomical variations and could be a valuable tool in anatomy identification in various populations (Baratz et al., 2019). This new technology recently became available to Marian

University's health science department and has not yet been added into the SRNA's curricula. In general, students are nervous or may have inconsistent experiences within the clinical environment in performing PNBs, emergency cricothyrotomy, identification of cranial nerve innervation and neurovascular assessment via train-of-four.

According to research, twenty-first-century medical students are encaustic and engaged with learning anatomy utilizing technology, which can be instrumental in creating or improving both students and faculties learning experiences (Baratz et al., 2019). Baratz explored the effectiveness of learning gross anatomy of the same regions via traditional cadaveric dissection and using the Anatomage table and found quiz scores to be the same regardless of learning modality except in the musculoskeletal system where the Anatomage Table group had significantly higher average quiz score (Baratz et al., 2019). The Anatomage Table group also expressed a significantly higher degree of excitement, perceived degree of comfort and preparedness (Baratz et al., 2019). The importance of thorough knowledge and competence of anatomy to clinical application is irrefutable, and with the limitations of traditional teaching modalities and cadaveric dissection, research suggests that multimodal pedagogical methods are most effective at teaching students' anatomy when used in a complementary manner (Baratz et al., 2019). The implementation of cutting-edge technology to improve students' understanding of anatomy can prove valuable as studies show a correlation with its use and a positive impact on students' perceptions on academic success (Baratz et al., 2019).

Literature Review Methods

This review of the literature sought articles specific to the use of an Anatomage Table/virtual dissection table in anatomy education. The literature search was conducted in December 2021, in three databases under four platforms: MEDLINE-Ovid, MEDLINE-Ebsco,

CINAHL-Ebscohost, and Google Scholar. A comprehensive search utilizing: advance search, keywords, synonyms, Boolean/Phrase, and Medical Subject Headings [MeSH] terms were used. The database search was limited to articles published in the English language, conducted on humans, and classified as a Clinical Trial (CT) or Randomized Controlled Trial (RCT), cohort study and retrospective studies. Primary terms used to search MEDLINE-Ebsco, CINAHL-Ebscohost and MEDLINE-Ovid database were *Anatomage, anatomy education, 3D visualization OR 3-d visualization, and virtual cadaver, virtual reality, anatomy [Education], anesth$, Anatomage, three-dimensional image or imaging, Three-Dimensional/, 3D visualization, 3-dimensional, education.* The following Boolean phrases were used to narrow our search results to our specific topic; anatomy education AND 3D visualization OR 3-d visualization, virtual reality/ AND anatomy[Education], anesth$ AND virtual reality/, three-dimensional image or imaging, Three-Dimensional/ OR 3D visualization OR 3-dimensional, three-dimensional image or imaging, Three-Dimensional/ OR 3D visualization OR 3-dimensional AND anatomy[Education], anesth$ AND three-dimensional image or imaging, Three-Dimensional/ OR 3D visualization OR 3-dimensional, education AND anesth$ AND three-dimensional image or imaging, Three-Dimensional/ OR 3D visualization OR 3-dimensional. All articles that resulted from searching the keyword Anatomage were reviewed for relevance to the research topic. Lastly, Google Scholar was searched using the Anatomage virtual dissection table as the search term and all 375 results were scanned for relevance to the research topic. Exclusion criteria included meta-analysis and systematic review articles, posters, books, and non-sentinel articles that are not within the last five years. Full-text articles were reviewed and excluded based on lack of pertinence to area of focus, wrong intervention, and population of interest (i.e., simulation-based learning, Anatomage software, 3D non virtual Anatomage/dissection table, or

Anatomage for diagnostics). From the initial search results of 695 articles, 20 met criteria for inclusion in this review of the literature. These comprise varied types of studies which includes but are not limited to randomized control trials, quasi experimental, retrospective studies, and cross-sectional descriptive studies (See appendix A for a list of literature reviewed and appendix B Prisma diagram).

Review of the Literature

Anatomage Table and Research Samples

The effects/outcomes of the use of the AT as teaching pedagogy in learning anatomy was explored as a means of improving academic performance, knowledge, radiologic interpretation, as well as a 3D dissection tool, and as an effective teaching method. The literature reviewed provided quantitative and qualitative evidence of the pivotal role and impact of teaching and learning anatomy utilizing a 3D virtual anatomy table such as the Anatomage Table (AT) and Sectra Table (ST). The qualitative evidence evaluated students' perceptions and opinions regarding student satisfaction, usefulness, and effectiveness of learning. There was no significant difference in terms of age, gender, cohort, prior anatomy knowledge, or experience with the AT, cadaveric dissection, or virtual scalpels. There was equivalent prerequisite course work among the groups of participants enrolled in this review of the literature (da Silveira et al., 2021; Afsharpour et al., 2018; Bhadoria, 2021; Boscolo-Berto et al., 2021; Kazoka & Pilmane, 2019).

Impact on Scores

The literature was unanimous in showing an increase in students' knowledge and performance in Anatomy course work, with the implementation of these modern human sized digital touch-screen table technology (Narnaware & Neumeier, 2021; Bhadoria, 2021; Boscolo-Berto et al., 2021; Whited et al., 2021). Employing the AT as a modality of teaching anatomy to

medical students in more complex topics showed an increase in test grades, pre-exposure to AT (50.38±1.17(SE) compared to post-exposure to AT (56.94±1.18(SE) ($P < 0.001$) (Bhadoria, 2021). Further, an increase was found in the grades of students who were classified as poor performers (failing grade <50). An increase in grades was noted based on performance on monthly tests (16±1.83(SE), when compared to students classified as good performers (scored grades ≥ 50) whose grades increased about 3 points (3.3±2.08 (SE), which was statistically significant ($P < 0.001$) (Bhadoria, 2021).

In congruence with findings of improved academic performance with the use of an AT, the few studies conducted on nursing students demonstrated a positive impact on increased knowledge reflected through students' examination scores and grade point average (GPA) (Narnaware & Neumeier, 2021; Bianchi et al., 2020). Narnaware and Neumeier found the mean class average at mid-term#1, mid-term#2, mid-term#3, and final exam grades of students taught with the AT showed a significant increase when compared to students taught without the AT (See table 1).

Table 1. Scores on nursing exams in groups with and without exposure to the AT Table

	term1	term 2	term 3	final
Without AT	67.4 ± 3.4	63.8 ± 2.6	62.9 ± 1.4	64. ± 2.4
With AT	71.4 ± 2.8	68.3 ± 2.8	66.2 ± 1.5	68.9 ± 1.9

(Narnaware & Neumeier, 2021, p. 311)

Students using the AT had an overall higher GPA (3.0 ± 0.09), when compared to students taught without the AT (2.74 ± 0.12) ($P < 0.05$) (Narnaware & Neumeier, 2021). Bianchi et al. sought to find out if the implementation of the AT would enhance students' performance and

result in a decrease in anxiety and subsequently improve performance (2020). A State-Trait Anxiety Inventory (STAI) test was used to evaluate students' state of anxiety related to the final exam, and this revealed that the mean STAI score of the groups of students who attended the AT laboratory session (46.5) were significantly lower in comparison to the students who only attended the mandatory lectures (52.3) (Bianchi et al., 2020). They also found that none of the students in the AT group failed the final exam, compared to seven failures in the group without the AT ($p < 0.05$) (Bianchi et al., 2020).

Impact With Combined Methods

Some studies compared different teaching methods employed in improving students' learning of anatomy, such as the AT, plastinated specimens, cadavers, anatomical models, textbooks, and lectures (Abdulrahman et al., 2021; Afsharpour et al., 2018; Boscolo-Berto et al., 2021; da Silveira et al., 2021; Whited et al., 2021; Baratz et al., 2019; Anand & Singel, 2014; Kausar et al., 2020). Studies showed that the use of only one of the teaching methods, the AT or others, in learning anatomy during the practical laboratory secession was not as effective as a combined approach (Abdulrahman et al., 2021; Boscolo-Berto et al., 2021; da Silveira et al., 2021; Baratz et al., 2019). Abdulrahman et al. found that students scored lower in an anatomy practical exam instructed using the AT (18±4.4) or plastinated specimens (18.3±4.6) alone, than students instructed using a combination of both teaching strategies (20.4±5.6) ($P = 0.0001$) (2021). Whited et al. not only found that a combination of cadaveric specimens and AT increased students' confidence and knowledge of pediatric anatomy in all five body systems (i.e., Head, Eyes, Ears, Nose and Throat [HEENT], cardiovascular, respiratory, musculoskeletal, and neurological) (2021). They also found that graduate nurse practice students experienced an additional benefit from pairing up after each laboratory session to utilize previously learned

health assessment skills, to immediately apply anatomical knowledge gained in the laboratory (Whited et al., 2021). An early study by Anand and Singel found no significant difference in students' test scores (P = 0.0979) between the use of the AT versus traditional dissection method in teaching neuroanatomy (2014).

Persistence of Impact

A question arises concerning whether the effects of combined teaching methods are seen only in lab examinations or if it is also reflected in overall course performance. Interestingly, a particular study comparing three pedagogies in teaching gross anatomy using cadavers, anatomical models, and AT in three different Doctor of Chiropractic student cohorts enrolled in a lecture and laboratory anatomy course, found significant improvements in laboratory exam scores between cohorts ($p < .001$), but no significant differences were seen in lecture exam scores (Afsharpour et al., 2018). The average midterm and final laboratory exam scores between cohort 1, cohort 2 and cohort 3 showed a successive significant increase (mean= 76.1%, 81.4%, and 85.1% respectively) in learning with cadavers, anatomical models, and AT respectively, but the mean lecture exam scores (61.2%, 62.4% and 61.1%) remained consistent between cohorts (Afsharpour et al., 2018). Baratz et al. also compared the use of the AT to cadaveric dissections in teaching about the pelvis and perineum (P/P) and musculoskeletal system (MSK), they found the AT group had a significantly higher average quiz score in the MSK ($p = 0.03$), but no difference was found between the two modalities in P/P during the post-lab quizzes (2019). However, the practical exam results showed no significant difference when the mean exam scores of the AT and cadaver practical exams were compared in both the P/P ($p = 0.83$) and MSK ($p = 0.41$) anatomical regions (Baratz et al., 2019).

Impact on Radiologic and Surgical Skills

Studies showed that the AT was useful as an educational radiologic imaging modality and as a dissection tool, as students were able to create incisions and cuts to remove and uncover different layers of organic tissues (Kazoka & Pilmane, 2019; Paech et al., 2017). Kazoka and Pilmane showed that the advantage of adding virtual scalpels to Human Anatomy course outweighed the disadvantages as students learned how to control the directions, length, and depth of all performed incisions, identify special anatomical structures, understand spatial relationships among organs and learned a variety of ways to better illustrate layer and topographical anatomy using 3D format (2019). Paech et al. evaluated three approaches to using radiologic anatomy (RA) in the teaching of general anatomy: group 1- included students training in RA seminar and cadaver CT scans on the AT; group 2 utilized RA seminar and group 3 had neither the seminar nor the CT cadaver/AT (2017). The AT and cadaver CT scan combination resulted in an average test score of 21.8 ± 5.0, when compared to RA seminar group alone (18.3 ± 5.0) and the group without any radiologic image interpretation training (17.1 ± 4.7) ($p < 0.001$).

Student Perception of the Anatomage Table

Determining student perception of the AT teaching modality is integral to the impactful use of the modality. Qualitative data from questionnaires, free text responses and Likert -type responses were reported in several studies (Narnaware, & Neumeier, 2021; Tenaw, 2020; Kazoka & Pilmane, 2019; Paech et al., 2017; Boscolo-Berto et al., 2021). In this literature review, studies were assessed for student overall satisfaction, perception of usefulness of the AT technology, perception of usefulness compared to other teaching modalities, and student assessment of the AT contribution to learning.

Student Satisfaction

Perception on student satisfaction with the use of AT was examined (Narnaware, & Neumeier, 2021; Tenaw, 2020; Kazoka & Pilmane, 2019; Paech et al., 2017; Boscolo-Berto et al., 2021) and most students in each study believed the implementation of the AT improved their comprehension of the human body. Students indicated they would recommend this teaching tool to other students and believed it provided a truer perception of the human body. However, there was less agreement as to the effectiveness of the AT when compared to other resources. Narnaware and Neumeier (2021) found that while 51.3% preferred the AT to the use of an actual human cadaver, 46.6% preferred a cadaver. Kazoka and Pilmane (2019) reported that 70% of the students were satisfied with the virtual dissection and/or their own prepared anatomical 3D models, but the students also highlighted the role and necessity of real dissection. A greater percentage however thought that use of virtual dissection with AT alone was enough to teach and study anatomy (45.25% students), while 24.75% preferred printed 3D anatomical models and the classical methods of learning and teaching anatomy (Kazoka & Pilmane, 2019). Students reported that the use of AT was a more engaging experience than studying textbooks and atlases (Boscolo-Berto et al., 2021). Boscolo-Berto et al. also reported that students cited advantages of performing procedures on life-size male or female virtual cadavers, viewed from different angles and tissue levels and were able to perform different types of cuts, create incisions, uncover different layers of tissue, reattach bones, muscles, blood vessels and back to the skin level (2021). Students enjoyed the virtual tools in the practical classes and said that they learned theoretical material better (Pilmane & Kažoka, 2019; Alasmari, 2021).

Anatomage Table Usefulness

Usefulness of the AT expressed by students in the teaching and learning of human anatomy was reported by Tenaw (2020) and Kazoka and Pilmane (2017). Both research studies showed that students found the AT to be interesting and an effective learning tool for developing their knowledge and skills, collaborative learning, and learning anatomical language of the structures. The students who spent more time with the AT had a more positive perception (Tenaw, 2020; Kazoka & Pilmane, 2017; Fyfe et al., 2018). Students appreciated the active participation, the ability to manipulate the virtual cadaver, and the topographical relationship between anatomical structures to better understand relational anatomy and cross-sectional imaging (Kazoka & Pilmane, 2017).

Student Perception of AT Compared with Other Teaching Methods

When comparing the AT with other teaching modalities such as human cadaveric specimen, plastination specimen, as well as combination of modalities (multimodal approach), there were more positive attitudes from students in favor of a combined teaching model as opposed to a sole teaching modality (Abdulrahman et al., 2021; da Silveira et al., 2021; Alasmari, 2021; Kazoka & Pilmane 2019). The 3D Anatomage Table was preferred as an additional tool to cadaveric dissected specimens in learning anatomy. Kazoka and Pilmane (2019) reported that students gave preference to a combination of real and virtual dissection and printed 3D models, reinforcing their objective research finding that use of the combined methodology increased the students' learning experiences. When students reported that they were more excited and perceived a greater degree of learning while using the AT Table, they also showed objective improvement in test performance as reported above (Baratz, 2019). Students' practical engagement was found to enhance active learning (Alasmari, (2021; Baratz, 2019;

Kazoka & Pilmane, 2017). Making sagittal, parasagittal, coronal, and transverse sections of the digital body in 3D AT boosted their understanding of relational anatomy (Alasmari, 2021). Taken together, the findings of these studies indicated that the addition of an AT to traditional teaching modalities has consistently been viewed as a positive enhancement to anatomy education.

Student Perception of AT Effectiveness of Learning Anatomy

Most of the students agreed that virtual dissection with AT deepened their understanding and improved their learning experience (Bhadoria, 2021; da Silveira et al., 2021; Anand & Singel, 2014; Custer & Michael, 2015). Students stated that it provided them with a three-dimensional perspective of structures and helped them recall (Bhadoria, 2021). Students reported that learning took less time compared with traditional learning (da Silveira et al., 2021; Anand & Singel, 2014). Most students found the AT to be an effective teaching tool because it allowed them to visualize relative size of different parts of brain and spinal cord better, visualize relations of different parts better and enhanced overall classroom experience (Anand & Singel, 2014). Students also felt that they were better prepared to enter the health care profession (Custer & Michael, 2015).

Student Perception of a Similar Virtual Anatomical Table Technology

Like the AT are other 3D dissection tables for example, the Sectra Table and Sectra Board (Sectra Group, Linköping, Sweden) which have also been studied and yielded similar results of student satisfaction (Kausar et al., 2020; Whited et al., 2021; Bianchi et al., 2020). Student feedback from these studies revealed the perception of students regarding the use of Sectra. All the students showed strong positive responses towards the use of Sectra, and none responded negatively. Whited et al. (2021) reported qualitative data revealing many positive

themes in relation to the anatomy review experience. Most of the students reported that using the 3D Sectra Table and prosected cadavers was a beneficial experience (Whited et al., 2021). Overall, students reported that they had a much more in-depth understanding with Sectra than they had viewing images in a textbook. A student, identified as a visual learner, stated: “It really helped connect where everything is located, and also why and how certain systems work” (Whited et al., 2021, p. 350). Other students cited benefits that included interactivity, use of images from real patients instead of “generic illustrations,” and use of case studies in combination with the images and scans. Bianchi et al. (2020) reported that 100% of students indicated “satisfying” or “very satisfying” as their degree of interest in the subject, the quality of the AT and its useful application in their nursing education. All the students in the Bianchi study also described their level of knowledge as “satisfying” or “very satisfying.”

In summary, qualitative data on the use of AT reported high levels of student satisfaction. Similar results were found for studies in which a similar table, the Sectra Table, was used. It appears that a high quality virtual anatomical teaching table, the AT, produces quantitative and qualitative improvements in anatomy education. The Sectra Table research also supports the use of the virtual anatomical teaching tool, although it is beyond the scope of this paper to determine if one table is preferable to the other.

Theoretical framework

The framework used to guide this project is Kolb's experiential learning theory. The theory is represented by a four-stage cycle which the learner must execute for an effective learning experience (Kolb & Kolb, 2009). The four stages of the model are as follows:

Stage 1. having a concrete experience, followed by

Stage 2. an observation of and reflection on that experience which then leads to

Stage 3. the formation of abstract concepts and that are in turn, finally used to test

Stage 4. hypothesis resulting in new experiences.

In addition to providing a process for experiential learning, Kolb emphasizes the concept of individual learning styles as well as an opportunity for each learner to acquire knowledge, based on their individual preferences (Kolb & Kolb, 2009). The learning styles are not addressed in this project. (See appendix C-Framework).

Stage 1 Concrete Experience

Students encountered a new experience by watching Anatomage Table instructional videos on navigating the virtual 3D human cadaver. These videos were aimed at enhancing base knowledge on the airway anatomy structures, muscles and Peripheral nerve innervation.

Stage 2 Reflective Observation of the New Experience

Reflective observation occurred during and after the simulation debriefing phase. Students were invited to give a review, reflections and feedback on the videos watched and the active participation experience with the Anatomage Table. The students' human anatomy self-efficacy was evaluated using a self-efficacy instrument developed by Baldwin et al. (1999).

Stage 3 Abstract Conceptualization

The students were allowed to consider the relevance of the Anatomage Table experience and were also encouraged to consider new ideas to utilize the Anatomage Table.

Stage 4 Active Experimentation

During the active experimentation phase, learners applied what was learned into practice. They navigated through the Anatomage table performing different activities and case studies.

Aim

The aim of this project was to develop, pilot, and evaluate the perceived benefits of an Anatomage table to improve the knowledge of clinical anatomy and enhance performance of point-of-care assessments and interventional anesthesia procedures.

Objectives

1. Develop Anatomage Table instructional videos by March 2022
2. Provide guidance navigating Anatomage Table during the experimentation phase
3. Utilize a self-efficacy scale after the active experimentation phase
4. Utilize pretest-posttest design before and after active experimentation phase
5. Examine the differences in the pretest and posttest scores during summer of 2022

SWOT Analysis

In conducting a Strength, Weakness, Opportunities, and Threats (SWOT) analysis to evaluate the overall project design highlighted several factors that will help in anticipating challenges and steer the project down a successful path. The application of technology in the field of medicine has grown over the years and is responsible for breakthrough medical advances and its role in understanding anatomy is evident. Twenty-first-century medical students enjoy learning anatomy with technology such as the Anatomage Table and report improved learning experiences (Baratz et al., 2019). The Anatomage Table is an expensive learning tool, and with one shared amongst the health science departments, it creates limited access for participants to practice training interventions. Successfully acquiring more and implementing the Anatomage Table would

strengthen the CRNA programs curriculum, potentially making it known as one of the best CRNA programs in the Midwest due to the potential for increased knowledge, confidence, and success in performing procedures that require a sound knowledge of anatomy in the community. And lastly a foreseen threat towards the project being implemented permanently within the CRNA's programs curriculum is lack of faculty training. With an already full curriculum in place, housing this project and finding a good fit for it within the curriculum could be a problem, thus making it a stand-alone tool that can be easily forgotten. (See appendix D- SWOT Analysis).

Project Design / Methods

An educational intervention design was chosen to effectively answer our PICOT question and address this project's aims. To further explore this project's goals, a mixed methods design--specifically the sequential explanatory design type-- was used to obtain data for the project. A mixed methods design, combining quantitative and qualitative measures, provided a more complete and nuanced investigation of our PICOT question. The sequential explanatory design is preferred because it retains the exact order in which the quantitative and qualitative data will be collected for this project. We followed the requirements of the sequential explanatory design which typically first collects quantitative data by using a pre and post-test and result from a PNB simulation exam (interscalene), followed by qualitative data utilizing an open-ended questionnaire, a self-efficacy tool and lastly, a final explanation/analysis.

Project Site and Population

This DNP project was implemented at a private, liberal arts university in the Midwest. The target population was the first year Students Registered Nurse Anesthesia (SRNAs). There was equivalent prerequisite course work amongst participants, none having prior experiences with the AT. Inclusion criteria included first year Nurse Anesthesia Students and exclusion criteria included unwillingness to participate in the project and prior experience with the AT.

Recruitment methods included an email sent out to the first year SRNAs to seek volunteers and another email sent out seeking participation from all SRNAs.

Measurement Instruments

A quantitative pre and post-test was utilized to measure baseline anatomical knowledge as well as knowledge change after pre-briefing videos and AT simulation teaching intervention.

The project team worked in collaboration to create the aforementioned tests and videos. The test consisted of 5 questions that were a combination of multiple choice, select all that apply, and matching questions see appendix E. The open-ended questioner consisted of 3 questions. See appendix F. For assessing educational process change, the Anatomy Self-efficacy instrument was used (Burgoon, 2012). This tool was originally developed by Baldwin in 1999 and called the Biology Self Efficacy Scale and has been subsequently modified by several other authors (Burgoon, 2012; Ainscough, 2016). The DNP project team made minor changes, with permission from the author to meet our specific needs but to maintaining the validity and reliability of the tool The Anatomical Self-Efficacy Instrument was incorporated into a survey and was filled after the AT intervention. The coefficient alpha for the anatomical self-efficacy instrument (composed of all 16 items) ranged from 0.90 to 0.96 depending on the survey administration, indicating the scale had a high degree of internal reliability (Ainscough et al., 2016; Burgoon et al., 2012). (See appendix G- Anatomical Self-Efficacy Instrument).

Data Collection Procedures

By implementing the AT as a teaching modality (intervention) we hoped to ascertain if students experience increased knowledge (outcome) and efficacy (outcome) to enhance their clinical performance of peripheral nerve blocks (PNBs) (outcome) as determined by the analysis of data collected pre and post implementation of interventions. To utilize the AT to properly ascertain the outcomes, this project used two pre-briefing videos demonstrating the use of the AT in learning two anatomical topics, followed by a simulation teaching session. To collect data to evaluate the effectiveness of our project, a pre-test was administered before participants viewed the pre-briefing videos, and prior to the simulation teaching sessions. After the simulation session a post-test, self-efficacy assessment and data from an open-ended questionnaire was

obtained to analyze the impact on knowledge and self-efficacy. See appendix H for the self-efficacy survey on PNB. In addition, data needed to assess enhanced performance on PNBs were collected by asking for volunteers from the sample population and providing them with a simulation teaching session after they have listened to the lecture portion of PNBs, and their traditional simulation teaching. No participant was denied access to the traditional teaching methods (lecture and simulation time). However, the volunteers received additional training on PNBs with the AT before the sample population's practical test out exam, to assess if volunteers from the sample population experienced enhanced performance during the test out. This process ensured an accurate measurement on the impact of the AT. This additional teaching with the AT was strictly voluntary to protect the integrity of this DNP project because the students willingly volunteered for this extra teaching modality. Students' data from the test was de-identified by the simulation professor. This was done by assigning numbers instead of names to grades obtained before the data was made available to the designers of this project. The other pre-briefing video (Laryngeal Airway anatomy and nerve innervation) and simulation teaching session was provided to the entire sample population but only knowledge and self-efficacy was evaluated. See appendix I for the self-efficacy survey on Laryngeal airway anatomy and nerve innervation Simulation.

The project design takes guidance from recent reports from committees concerned with advanced nursing practice education. Incorporating recommendations from the Healthcare Simulation Standards of Best Practices, we provided pre-briefing videos to teach participants how to utilize the AT to learn three anatomy topics that are vital for an SRNA (INACSL, 2021). According to the International Nursing Association for Clinical Simulation and Learning's (INACSL) best practices, pre-briefing videos ensure that simulation participants were adequately

prepared for the educational content and are knowledgeable in the processes and procedures for the simulation experience(2021).

Ethical Considerations / Protection of Human Subjects

This DNP project was deemed exempt by the Marian University Internal Review board (see appendix J).

Data from the participants were collected through pre and post-test and self-efficacy surveys provided via Canvas. In addition, data from the open-ended questionnaire was collected electronically and went through a de-identification process by the course faculty before it was made available to the designers of this project for statistical analysis. Access to data was limited to the course faculty and the designers of this project. No risks were identified. Consent was implied by the willingness to participate. participate in the AT training intervention had the opportunity extended to them after the data collection was completed.

Project Evaluation Plan

For the quantitative analysis of the data, a Wilcoxon signed ranked t-test was utilized to evaluate the effectiveness of the pre-briefing videos and AT simulation teaching intervention by determining if the difference between the pre and posttest were statistically significant. An independent samples t-test was utilized to analyze the PNB check off examination scores of the SRNAs who participated in the AT training intervention to those who did not participate in the AT intervention. To analyze the qualitative data, a structured analysis method was utilized where thematic analysis of the open-ended questionnaires was evaluated, identifying patterns of themes in the interview data. Lastly, descriptive statistics were utilized to analyze data from the Self Efficacy Instrument.

Data Analysis and Results

Quantitative Results/Analysis

Laryngeal airway anatomy and nerve innervation Simulation: Pre & Post test

For the quantitative analysis of the data, a Wilcoxon t-test was utilized to evaluate the effectiveness of the pre-briefing videos and AT simulation teaching on laryngeal airway anatomy and its innervations. Overall, the SRNAs were able to achieve markedly higher scores in the airway anatomy knowledge posttest when compared to the pretest. In the sample size of 27 SRNAs, the mean of the test scores increased from 9.40 ± 2.46 in the pretest to 10.56 ± 2.42 in the posttest (see table 3). However, no statistically significant difference was found in the results (W = 93.000, z = -1.629, p = 0.052, r=-0.313) (see table 2).

Table 2.

Wilcoxon signed rank

Paired Samples T-Test

Measure 1		Measure 2	W	z	df	p
Pre	-	Post	93.000	-1.629		0.052

Note. For all tests, the alternative hypothesis specifies that Pre is less than Post.

Note. Wilcoxon signed-rank test.

Table 3.

Descriptive Statistics

	Pre-Test	Post-test
Median	10.000	11.000

Mean	9.407	10.556
Std. Deviation	2.469	2.423
Minimum	3.000	5.000
Maximum	13.000	13.000

N =27

The self-efficacy posttest survey was given to assess the self-efficacy of students after participating in Laryngeal airway anatomy and nerve innervation AT training. The maximum score on all questions was a 5 (Totally confident) while Q12 and Q13 had a minimum score of 1 (Not at all) (see table 4). For frequency tables on Laryngeal airway anatomy and nerve innervation Simulation Self-Efficacy posttest survey questions please refer to appendix K.

Table 4.

Laryngeal airway anatomy and nerve innervation Simulation: Self-Efficacy posttest survey

Descriptive Statistics

	Mean	**Std. Deviation**	**Minimum**	**Maximum**
Q1	3.727	0.761	2	5
Q2	3.636	0.699	2	5
Q3	4.03	0.684	3	5
Q4	3.667	0.645	2	5
Q5	4.03	0.684	3	5
Q6	3.879	0.6	3	5
Q7	3.939	0.659	3	5
Q8	3.818	0.808	2	5
Q9	3.727	0.719	2	5

Q10	3.788	0.696	2	5
Q11	3.97	0.728	2	5
Q12	3.545	0.905	1	5
Q13	3.364	0.895	1	5
Q14	3.788	0.696	2	5
Q15	3.697	0.684	2	5
Q16	3.879	0.65	3	5

N= 33

PNB Assessment Exam Results

A total of 33 SRNAs participated in the PNB (interscalene) skills examination. An independent samples *t-t*est was used to calculate the mean scores of participants who attended the Anatomage Table (AT) training prior to the check off examination (project group) and the mean scores of those that had no AT training prior to the check off examination (comparison group). No significant difference was found ($t(31)= -0.536$, $p>0.05$)(see table 5). The mean of the AT trained participants (M = 94.118, *sd* = 16.606), was not significantly different from the mean of those that did not have the AT training (M = 96.875, *sd* = 12.500) (see table 6).

Table 5.

Independent Samples T-Test

						95% CI for Mean Difference	
	t	df	p	Mean Difference	SE Difference	Lower	Upper
Scores	-0.536	31	0.596	-2.757	5.142	-13.244	7.730

Note. Students' t-test

Table 6.

Group Descriptives

	Group	N	Mean	SD	SE	Coefficient of variation
Scores	AT training	17	94.118	16.605	4.027	0.176
	No AT training	16	96.875	12.500	3.125	0.129

The self-efficacy posttest survey was given to assess the self-efficacy of students after participating in PNB training with the AT. The maximum score on all questions was a 5 (Totally confident) while Q13 had a minimum score of 2 (Only a little confident) (see table 7). For frequency tables on PNB Self-Efficacy posttest survey questions**,** please refer to appendix L.

PNB Self-Efficacy Survey

Table 7

Descriptive statistics

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16
Mean	4.58	4.58	4.42	4.58	4.42	4.17	4.42	4.33	4.5	4.42	4.42	4.42	3.58	4.08	4.17	4.58
Std. Deviation	0.52	0.52	0.67	0.52	0.79	0.72	0.67	0.65	0.67	0.52	0.52	0.79	0.9	0.67	0.72	0.52
Minimum	4	4	3	4	3	3	3	3	3	4	4	3	2	3	3	4
Maximum	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5

N = 12

Qualitative Results/Analysis

Evaluation of the Perceived Benefits of Utilizing the Anatomage Table to Enhance Knowledge of Clinical Anatomy

Participants were asked three open ended qualitative question regarding perception of the AT as an adjunct to facilitate knowledge and competence in identifying anatomical structures that would translate to safety in performing peripheral nerve blocks (PNB) and laryngoscopy in the clinical setting. These questions included: 1. In what ways they felt the knowledge gained from the utilization of the AT would be helpful in their clinical and future practice as a CRNA 2. In what ways was the AT laboratory experience beneficial or not to their understanding of airway anatomy and innervation and lastly, 3. In what does the AT compared to prior methods utilized to learn airway anatomy. A total of 33 participants were involved in this DNP project.

Three themes emerged from the analysis of the three open ended qualitative questions posed to the participants in a survey. These themes were: effective teaching tool, enhanced retention, and superiority of the AT teaching technique over other teaching modalities they had experienced. A full list of themes and codes are available in Table 7. Each of these themes will be discussed below with codes and exemplars.

Table 7

Theme	Code
Effective teaching tool	Enhanced Knowledge of anatomy
	Positive impact on clinical preparedness
Enhanced retention	Visual and kinesthetic learning
	Interactive 3D learning
Superiority	Realistic and applicable
	Engaging and communication

Effective teaching tool

Of the 33 participants, all 33 (100%) indicated in the first question asked that the AT was an effective teaching tool which solidified their knowledge of anatomy, and positively impacted their confidence and preparedness for clinical competence. The two codes that were identified with this theme are: enhanced knowledge of anatomy and positive impact on preparedness.

One of the participants replied stating that with the AT laboratory experience “I will be able to better identify and be able to know where nerves come from and the tract they take as well as know the anatomy I am looking at while intubating.” Utilizing the AT Table to learn airway anatomy and its innervations provided a sound working knowledge and mental representation of structures necessary to safely identify structures while executing an intubation was a benefit that occurred in 24 survey responses. Two other participants reported that “I can better picture the innervation of the airway. Also, I can better identify the structures of the oral airway when intubating” and “I would like to continue studying with the Anatomage Table and I will use the knowledge of airway anatomy for class and clinical practice (knowledge of structures, functions, and associated injuries, etc.” respectively.

The AT having a positive impact on clinical preparedness also appeared 8 times in the survey responses where participants made statements such as “This hands-on experience was very beneficial, and I think it will assist me in being more confident in clinical practice. Being able to visualize different structures and see the whole picture was incredibly helpful.” Participants' responses were unanimous that their interaction with the AT solidified their knowledge and gave them a boost in confidence and decreased stress knowing they are equipped with knowledge to answer their preceptor questions in real-life airway scenarios. In similar comments, a participants indicated that “This experience gives access to the most up-to-date simulation and allows for removal of structures for better visualization of procedures we will be

performing in the future", and the other stated that "When I am verbalizing what I am visualizing to my preceptor during intubation, I feel that I will be confident in identifying structures."

Enhanced retention

A corresponding theme was notated to the 33 participants' responses to the second survey question. All 31 (89.77%) participants discussed enhanced retention as a benefit of the AT in enhancing knowledge of clinical anatomy. Two codes were identified from the responses, which include: visual and kinesthetic learning, and interactive 3D learning. The most frequent comments on this theme consisted of both codes equally. The participants strongly believed that the AT was instrumental in emphasizing concepts through its 3D future, color coding, labeling and its ability to peel off structures to allow for visualization of deeper structures unlike a cadaver. Some participants stated that with the AT "Being able to see it helps commit to memory" and some participants were specific about how the AT aids to commit anatomy to memory by allowing for visual and kinesthetic learning. A participant stated, "I thought it was very helpful, I feel that I am a slow learner and would like to actually visually touch the table myself and then go back and forward when needed to fully retain what I am learning." Another participant responded by saying "I love the colors provided in the anatomage. In the cadaver lab I can't easily differentiate structures when they're all the same color. The anatomage provides color and an easy 3D view."

Along with visual and kinesthetic learning, participants stated that the AT creates an interactive 3D learning experience (15 responses). One participant compared the AT experience to the traditional use of mannikins for simulation stating that "The visualization makes the structures more realistic compared to mannikins." A few other participants were impressed and valued how it simplified learning and understanding the intricacy of the muscles, nerves, and its

relationship to surrounding structures. A participant notated “It helped me see how the RLN follows a groove on its way back up and how that is at a great risk of being damaged in a surgery.” Some other participants responded stating that, “Being able to peel away structures and see them from all angles is invaluable in understanding innervation.” Another said that “The Anatomage Table is much easier to see and learn the anatomical structures more so than the cadavers.” Another responder appreciated the life-sized 3D interactive learning previewed by the AT, stating that, “visually seeing the structures in detail was helpful for putting it all together and understanding the proportions of the muscle sizes."

Superiority

From 32 (89.44%) participants, the third theme was observed from responses to the third survey question that compared previous methods utilized to learn airway anatomy and its innervation to the AT. 2 codes were formed from survey responses: realistic and applicable, as well as engaging and communicative. Most of the responses addressed the realistic and the applicability of the AT in learning anatomy. Participants saw the implementation of the AT to be valuable in creating a more mirror image of real-life anatomy that would aid in the clinical application of knowledge. As one participant said, “I think it would be a great adjunct to use when learning dense anatomy, such as those featured in our neuroanatomy lectures as well as identifying structures that we will be encountering when performing procedures.” Another said, “Very useful, very realistic view.” Four participants compared learning airway anatomy and its innervation with Apex (CRNA board preparation tool), and cadavers versus the AT. A participant said, “I prefer the table because of the visual representation resonates better than reading about the anatomy and still APEX pictures.” Another participant reported that “Apex modules give mnemonics to help remember structures functions, but the table allows for direct

visualization." Another participant said "I think the Anatomage Table was so much better than any textbook picture or apex. I also think it is way better than the cadavers and I wish it was utilized more frequently."

Most of the participants also found the AT to be engaging and communicative (13 responses). Traditional teaching methods are not always engaging and interactive as the "Anatomage Table is a lot more visually appealing compared to the cadaver lab. The colors help to see a thorough picture of the anatomy. Also, being able to peel back unnecessary layers and structures using the Anatomage Table was super helpful." Another said, "We have been able to look at cadavers, however the table provides a greater 3D view for us in order to see every angle that the nerves and muscles are located." Participants believed that the AT "was an additive to the previous methods as the new technology allowed for a deeper level of understanding through the labeling and color coordinated features."

Quantitative Discussion

The medical field is ever evolving and the implementation of interactive technology to learning anatomy is no exception. The use of the AT as an adjunct to learning anatomy in college institutions is new, hence the limited data in the literature regarding its impact in student's learning. This limitation inspired this DNP project. This DNP project utilization of the AT to improve knowledge of clinical anatomy and enhance performance of point-of-care assessments and interventional anesthesia procedures.

The results for this DNP project showed that the SRNAs who watched the pre-briefing videos and attended the AT training achieved markedly higher scores in the airway anatomy knowledge posttest when compared to the pretest. While this was not statistically significant, it was close to the threshold and more data sampling might be needed to find a more definitive

result. The practical importance of the AT training effect cannot be overlooked as this indicates a noticeable clinical effect despite a small sample size. Higher posttest scores may suggest that the AT may be a more effective modality for short-term retention of information; however, further investigation with a larger sample is recommended.

These findings are in congruence with literature in showing an increase in students' knowledge and performance in anatomy course work, with the implementation of these modern human sized digital touch-screen table technology (Narnaware & Neumeier, 2021; Bhadoria, 2021; Boscolo-Berto et al., 2021; Whited et al., 2021). A consistent theme in literature are findings of improved academic performance with the use of an AT, and increased knowledge reflected through students' examination scores and grade point average (GPA) (Narnaware & Neumeier, 2021; Bianchi et al., 2020).

The overall time students worked with the AT (30 min), was very short with respect to their overall study hours during the preclinical anatomy course. However, despite the limited interaction time the project provided valuable insights in establishing potential integration of the AT into the Anesthesia curriculum. Nevertheless, future investigations with a larger sample size and longer working hours with the AT are required to verify the findings and to establish this technology as a valuable, supplemental learning modality. Moreover, most of the students had no prior knowledge or exposure to the AT. The AT technology learning curve coupled with the limited time presented an unfavorable impact on the interpretation of the results in this DNP project.

Of the 33 SRNAs from the project group, only 27 data samples were analyzed. We had 33 responses to the pretest but only 27 responses to the post test. The pretests that did not have a corresponding posttest were eliminated from this project.

After further analyzing the data, it appeared that a few of the respondents randomly selected responses in order to complete the test as quickly as possible rather than answering the questions honestly. Of the 27 that were analyzed, two left at least one question blank and four answered the question correctly on the pretest but missed it on the post test. This does make a difference in the overall results for knowledge gain. It is possible that if all responses were answered honestly, the results may have been statistically significant.

17 of the 33 SRNAs voluntarily attended AT training for PNB before taking their end-of-year check off exam while 16 SRNAs took their check off exams without attending AT training. The results of this DNP project most of the SRNAs were able to score 100% on the exam with the exception of two students in the project group and one student in the timed, and students did not fail the skill based on the ability to perform the task, but simply due to time constraint. Those that failed to score 100% could not perform the task within the time allotted. The goal of this project was to teach and assess identification of anatomy structures and to safely perform a PNB. Assessing how fast a PNB is performed was beyond the scope of this DNP project. Failure to attain 100% may have been erroneously synonymous with failure to perform a PNB. There is potential for future students to expand on this project. Future investigations are recommended,

Thirty-three SRNAs who participated in the Laryngeal airway anatomy and nerve innervation AT training were given a post self-efficacy survey. The survey was given to assess the self-efficacy of students after participating in Laryngeal airway anatomy and nerve innervation AT training., the question relating to confidence in active participation in airway anatomical discussion with professors using the AT, had the greatest number of students (21%) who rated a maximum score of 5 (totally confident). Questions 12 and 13, related to confidence in locating anatomical structures in the human cadaver and confidence in identifying

abnormalities respectively, both of which were not directly addressed in this project. It is therefore reasonable that these questions yielded.

17 of 33 SRNAs who voluntarily attended the AT training for PNB before taking their end of year check off exam were also given a post self-efficacy survey. The survey was given to measure self-efficacy (self-confidence) in the ability to perform PNBs (interscalene block) after utilizing the AT training. There was a moderate response rate (70%) to the survey, however there were some significant findings. 43% of the questions had a maximum score of 5 (totally confident). 58% of the SRNAs rated a maximum score of 5 on questions relating to confidence in identifying, performing, and answering questions on interscalene blocks. One student (8.3%) had a minimum score of 2 (only a little confident) on the question relating to confidence with identifying abnormalities on a patient in clinical setting. This project did not address identifying abnormalities. Even though identification of abnormalities is one of the features of the AT Table, it was beyond the scope of this project, so it is understandable that this could be one of the lower scored questions in the survey. In analyzing the results and based upon the feedback we received after the project was completed, we believe that the AT technology learning curve was impactful and could have affected their confidence in the overall AT learning experience.

Qualitative Discussion

This DNP project was conducted among first year CRNA students at Marian University. The qualitative part of this project aimed to assess the students' perceived benefits and overall satisfaction of the AT as an anatomy teaching tool to facilitate knowledge and competence in identifying anatomical structures that would translate to safety in performing anesthesia related procedures and interventions in the clinical setting. The students expressed a more positive attitude as a result of excellent anatomical knowledge gained from exposure to the AT. Twenty

participants went as far as comparing it to prior methods used to learn anatomy in the program (Apex, Cadavers, mannikins) and deemed their experience with the AT as far superior. Not all students perceived the AT as superior to prior teaching modalities but ranked it as equivalent and stated it would be a great adjunct to current anatomy teaching tools. Two of the responses to the second survey question had some drawbacks. One noted that the learning curve due to the lack of familiarity with this new technology interfered with their learning of anatomy. The second responder noted that while it did show nerve connections, it was harder to teach function. The first responders' concern could be easily resolved with more exposure and interaction with the AT. The laboratory experience in this study was the first-time participants were exposed to the AT hands on. Even though we did provide a pre-briefing video going over some of its functionality and how to navigate the AT, the hands-on simulation was their first real experience with the technology. The second participant's concern is not a function that the AT or any other anatomy teaching modality can do as of present. The AT cannot simulate what stimulation of the cranial nerve on the laryngeal muscles would look like, but rather it provides an avenue to easily comprehend the functionality.

Review of participants responses showed that the majority of them found the AT to be an interactive, engaging, and effective teaching tool which helped them form a deeper understanding of core anatomical knowledge necessary to be safe, successful and confident in the clinical setting. The results from this DNP project teaching anatomy with the AT offered some unique advantages such as showing relationships between structures, allowing for removal of structures for better visualization and understanding, provision of colors to stay engaged and a better identification and differentiation between structures. Additional advantages also include accessibility without the presence of an instructor for students who need additional time

interacting with the AT. It allows a student to save work and revisit it numerous times to gain full comprehension. It provides a clean 3D view of structures that highlights the intricate details of the course of nerves, muscles, and ligaments. These attributes contributed to improved learning of anatomy. The AT enhanced active learning accordingly, this would help to develop skills for scientific reasoning, self-dependent study, and the value of teamwork and interpersonal skills.

This finding supports the idea that the CRNA students prefer the combination of anatomage and traditional styles in teaching and learning anatomy. Results of previous research confirmed that combining multiple teaching methods is the best way to teach modern anatomy. Interactive 3D learning methods such as the AT are more effective anatomy learning methods than traditional methods. Although no single teaching tool has been found to meet all curriculum requirements, the multimodal approach has been advocated as the best way to teach modern anatomy (Estai & Bunt (2016).

Conclusion

The effectiveness of AT was assessed through several methodologies to fully ascertain its pros and cons and deduce its value, if any to SRNAs knowledge of anatomy. Qualitative data gathered compared the pretest taken before the AT intervention teaching to the posttest taken after the intervention. The posttest scores were higher than the pretest scores. Another qualitative assessment data gathered assessed students' competence at identifying anatomical structures and their relationship to surrounding structures under the guidance of an ultrasound to safely perform and interscalene PNB. Results from this DNP project showed no significant difference between the means of the AT trained participants and those that did not have the AT training. However, the students in the AT group did not score low due to a lack of knowledge but as a result of time

constraints. Student's perceptions were evaluated, and the AT was found to generate significantly more excitement along with an interactive learning process that increased clinical preparedness and overall knowledge and confidence. Findings from this DNP project the Anatomage Table is an effective anatomy teaching modality that fosters retention and recall of information thereby creating a working knowledge for the anesthesia professional. However, further investigation with a larger cohort is recommended.

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Appendix A

Literature Review Matrix

Reference	Research Design	Purpose / Aim	Population / Sample n=x	Variables	Instruments / Data collection	Results
Narnaware, Y. R., & Neumeier, M. (2021). Use of a virtual human cadaver to improve knowledge of human anatomy in nursing students. *Teaching and Learning in Nursing*, *16*(4), 309-314.	A quasi-experimental subject design	To examine whether the introduction of the Anatomage Table (AT) as a teaching strategy in the human anatomy course for nursing students enhances their knowledge in gross anatomy, and (2) whether the AT provides a suitable visual perception of the human body to optimize the learning experience of nursing students	first year nursing students n= 635 Human Anatomy class comprising 60-80 students each were taught gross anatomy using didactic, passive teaching without the AT in Winter 2015, group 1 (n = 132). and Human Anatomy class comprising of 60-80 students taught using the AT in Fall 2015, Winter and Fall 2016, and Winter 2017, thus serving as a comparison group 2 (n = 503).	didactic passive teaching, Anatomage table (AT), enhancement of knowledge, optimize the learning experience of nursing students	Midterm exam scores, final exam scores, a satisfaction survey answered through a Likert scale of 1-5, i.e., outstanding, excellent, good, average, and unsatisfactory,	Statistical analyses indicated that teaching human anatomy using the AT resulted in significant increases in the class average for all three mid-term examinations and of the final examination relative to students taught without the AT. The mean class average of comparison group 1 versus interventional group 2 for mid-term#1 was 67.4+-3.4 vs.71.4+-2.8, mid-term#2, 63.8+-2.6 vs. 68.3+-2.8, mid-term#3 62.9+-1.4 vs. 66.2+-1.5 and final examination 64. +-2.4 vs. 68.9+-1.9. The over-all GPA for interventional group 2 was significantly ($P<0.05$) higher and was 3.0+-0.09 than comparison group 1 (2.74+0.12)
Afsharpour, S., Gonsalves, A., Hosek, R., & Partin, E. (2018).	Retrospective study	To compare student performance following a change in laboratory teaching methodology	3 cohorts of students enrolled in a musculoskeletal	The midterm and final laboratory examination scores,	Laboratory exams mean scores and Lecture examination mean scores.	The midterm and final laboratory examination scores were evaluated and showed successive increases in aggregate averages between cohort 1 (mean 1⁄4

Analysis of immediate student outcomes following a change in gross anatomy laboratory teaching methodology. *Journal of Chiropractic Education*, *32*(2), 98-106.		from cadavers to models to virtual dissection table in a musculoskeletal gross anatomy course.	gross anatomy course in a Doctor of Chiropractic program. The 1st cohort of students (n=352), The 2nd cohort of students (n=350), The 3rd cohort of students (n=393).	Lecture examination scores.		76.1%), cohort 2 (mean 1⁄4 81.4%), and cohort 3 (mean 1⁄4 85.1%). Lecture examination scores remained consistent between the cohorts at 61.2%, 62.4%, and 61.1%, respectively. Significant improvements were seen in lab exam scores between cohorts (F [2, 2113] 1⁄4 58.6, p, .001), and no significant differences were seen in lecture exam scores.
Paech, D., Giesel, F. L., Unterhinninghofen, R., Schlemmer, H. P., Kuner, T., & Doll, S. (2017). Cadaver-specific CT scans visualized at the dissection table combined with virtual dissection tables improve learning performance in general gross anatomy. *European radiology*, *27*(5), 2153-2160.	quasi experimental study	The purpose of this study was to quantify the benefit of the incorporation of radiologic anatomy (RA), in terms of student training in RA seminars, cadaver CT scans and life-size virtual dissection tables on the learning success in general anatomy	Three groups of a total of 238 students were compared in a multiple choice general anatomy exam during first year gross anatomy: (1) a group (year 2015, n1 = 50) that received training in radiologic image interpretation (RA seminar) and additional access to cadaver CT scans (CT + seminar group); (2) a group (2011, n2 = 90) that was trained in the RA seminar only (RA seminar group); (3) a group (2011, n3 = 98) without	Radiologic imaging (RA)interpretation training, CT scan seminar, conventional anatomy, student perception	Test scores, survey	The average test score of the CT + seminar group (21.8 ± 5.0) was significantly higher when compared to both the RA seminar group (18.3 ± 5.0) and the conventional anatomy group (17.1 ± 4.7) ($p < 0.001$).

			any radiologic image interpretation training (conventional anatomy group). Furthermore, the students' perception of the new curriculum was assessed qualitatively through a survey			
Boscolo-Berto, R., Tortorella, C., Porzionato, A., Stecco, C., Picardi, E. E. E., Macchi, V., & De Caro, R. (2021). The additional role of virtual to traditional dissection in teaching anatomy: a randomized controlled trial. *Surgical and Radiologic Anatomy*, *43*(4), 469-479.	A randomized controlled didactical trial	The purpose of the study was to examine if integrating the classical gross dissection with a supplemental virtual experience on digital human cadaver can improve the learning of anatomy with benefits on students' performance.	Second-year medical students enrolled in an elective anatomic dissection course (n=30). Experimental group (n=15), Control group (n=15).	Anatomical knowledge, test performance, mean variation score of post-experimental examination	The CONSORT guidelines and checklist for randomized trials. Pre-test and post-test.	The rate of completed tests was 76.7%. Better overall test performance was detected for the group that applied to the virtual dissection (OR 3.75 with 95% CI 0.91–15.49; $p = 0.06$). A comparable performance between groups in basic anatomical knowledge (p 0.45 to 0.92) but not muscles and 2D-3D reporting of anatomical structures was found, for which the virtual dissection was of tendential benefit (p 0.08 to 0.13). Medical students who applied to the virtual dissection were over three times more likely to report a positive outcome at the post-dissection test than those who applied to textbooks of topographical anatomy.
Kazoka, D., & Pilmane, M. (2019). 3D dissection tools in Anatomage supported	Quasi-experimental study	The main aim of the study was to present the usage and importance of 3D dissection tools in the teaching and learning of Anatomy	200 students of the Faculty of Medicine and Dentistry. The first group consisted of	Advantages and disadvantages of virtual scalpels of the Anatomage Table. Effectiveness of	Virtual dissection discussion answers to the questions about the usage of 3D dissection tool	Results of the study showed that the advantages of adding virtual scalpels to a human anatomy course outweighed the disadvantages. Students of both groups

interactive human anatomy teaching and learning. In *SHS Web of Conferences* (Vol. 68, p. 02015). EDP Sciences.		and to describe and explain the experience with Anatomage Table in Human Anatomy studies at R ̄ga Stradin ̧š University.	(n=100) students of the Faculty of Dentistry and second group consisted of (n=100) students of the Faculty of Medicine.	virtual tools in the study of human anatomy		reported the use of a virtual dissection tool to be very beneficial in classes.
Fyfe, S., Fyfe, G., Dye, D., & Radley-Crabb, H. (2018). The Anatomage table: Differences in student ratings between initial implementation and established use. *Focus on Health Professional Education*, *19*(2), 41-52.	Quantitative study	The aim of this study was for students to rate perception of the usefulness of the Anatomage table and other anatomy resources	two medical student cohorts (2013, n = 333; 2014, n = 329)	video/animations learning, models, plastinates, Anatomage table, students' perception of usefulness	Survey, Rating scale (1-100)	video/animations rated most useful for learning (77.8/100), models (63.9/100), plastinates (58.4/100) and the Anatomage table (42.4/100), In 2014, respondents rated the Anatomage table more favorably (42.4/100) than in 2013 (36.9/100) ($p = 0.022$). The Anatomage table was rated most helpful for understanding relative sizes of organs but least helpful for using correct anatomical terminology. Qualitative data showed that in 2013, students were frustrated by screen-freezing problems and low-quality graphics, issues that were mostly addressed by 2014
Kažoka, D., & Pilmane, M. (2017). Teaching and learning innovation in present and future of human anatomy course at RSU. *Papers on Anthropology*, *26*(2), 44-52.	Case study design	The aim of the study was to investigate the usefulness of the Anatomage Table (Virtual Dissection Table) and overall satisfaction among students in the teaching and learning of human anatomy at RSU.	The sample included Latvian and Foreign students and several tutors from the Human Anatomy course in the period of 2016–2017.	knowledge	Discussion session	The assessment of the discussions of students showed that most of them found that the Anatomage Table was an interesting and effective learning tool for developing their knowledge and skills, collaborative learning, using the anatomical language of images of dissections. The results from the current study suggested that teaching Human Anatomy with the Anatomage Table offered some advantage on the questions requiring relationships between structures.

Tenaw, B. (2020). Teaching gross anatomy: anatomage table as an innovative line of attack. *Int J Anat Var Vol*, *13*(1), 76.	Cross sectional study	The aim of this study was to explore the practicality of the virtual body dissection table and inclusive gratification among medical students in the teaching and learning of gross human anatomy.	Eighty-nine study participants (51 males and 38 females) second year medical students	Anatomage table, students' satisfaction/gratification	10-item Questionnaire	80.89% of medical students study participants were satisfied that the anatomage had a helpful starring role and it was a supplementary tool for their learning and learning human anatomy and gives well-known numerous benefits of using the Anatomage table in the medical teaching and learning activities.
Abdulrahman, K. A. B., Jumaa, M. I., Hanafy, S. M., Elkordy, E. A., Arafa, M. A., Ahmad, T., & Rasheed, S. (2021). Students' Perceptions and Attitudes After Exposure to Three Different Instructional Strategies in Applied Anatomy. *Advances in Medical Education and Practice*, *12*, 607.	A cross-sectional study	The study aimed to assess medical students' performance and overall satisfaction who used the Anatomage table and plastinated specimens for the teaching and learning anatomy courses and enrich academic knowledge with different anatomy teaching methods.	211 students of the first-year college of medicine at Imam Mohammad Ibn Saud Islamic University (IMSIU). Group A (n=70) learned with the Anatomage table and Group B (n=70) learned the same topics on plastinated specimens. Group C (n=70) was learned on both plastinated specimens and the Anatomage table	Students' views on educational methods. Exam scores	Objective structured practical exam-ination (OSPE) and a structured questionnaire using a 5-point Likert-type scale	There was a statistically significant difference between the means of the total scale scores for the three teaching methods, where students expressed a higher attitude towards both strategies for teaching in comparison to the anatomage table and plastinated models for teaching, where the means were 18±4.4, 18.3±4.6, 20.4±5.6, respectively, F=12.6 and P=0.0001. There were higher and positive students' attitudes regarding the five statements in favor of both models teaching compared to anatomage table and plastinated model teaching alone.
Alasmari, W. A. (2021). Medical Students' Feedback of Applying the Virtual Dissection Table (Anatomage) in Learning	A cross sectional descriptive study	The aim of this study was to address students' opinions on applying the virtual dissection table (3D Anatomage) as an additional tool to cadaver dissection in learning anatomy.	Medical students n= 78	Use of 3D anatomage, students' opinion	6-question electronic questionnaire	81% (no=63/78) of the students preferred using 3D Anatomage as an additional tool to cadaveric dissected specimens in learning anatomy. 73% (no=57/78) of the students indicated that they benefited from applying the virtual 3D Anatomage in anatomy education (73%) (no=57/78) of the students found that applying 3D Anatomage during anatomy practical sessions with the

Anatomy: A Cross-sectional Descriptive Study. *Advances in Medical Education and Practice, 12*, 1303.						engagement of students in the discussion enhanced active learning 86% (no=67/78) of students strongly agreed that making sagittal, parasagittal, coronal and transverse sections of the digital body in 3D Anatomage boosts their understanding of the locations and relationships of the different internal body structures. A high proportion of 90% (no=70/78) of the students believed that the ability to rotate the digital body and dissect in 3D Anatomage helps in visualizing the body system. (72%) (no=56/78) of the students preferred the incorporation of imaging in 3D Anatomage, since it enables them to understand anatomy envisioned through medical imaging
Baratz, G., Wilson-Delfosse, A. L., Singelyn, B. M., Allan, K. C., Rieth, G. E., Ratnaparkhi, R., ... & Wish-Baratz, S. (2019). Evaluating the anatomage table compared to cadaveric dissection as a learning modality for gross anatomy. *Medical Science Educator*, *29*(2), 499-506.	A crossover design study	The purpose of this study was to compare the effectiveness and qualitative experience of learning gross anatomy of the pelvis and perineum (P/P) and musculoskeletal system (MSK) via cadaveric dissection to learning these same anatomical regions using the Anatomage table.	16 first year medical student's volunteers	Cadaver, anatomage, effectiveness and qualitative experience, exam scores, quizzes	Likert scale survey, Pre and post quizzes, practical examination	In the pre-lab survey, the groups did not demonstrate a statistically significant difference in perceived degree of comfort or degree of preparedness. However, the Anatomage group expressed a significantly higher degree of excitement than the control group for both blocks ($p < 0.01$). The results of the post-Lab survey for P/P and MSK comparing the combined intervention (Anatomage) and control (dissection) groups. While the groups did not demonstrate a statistically significant difference in perceived degree of difficulty in the post-Lab survey, there were significant differences in perceived "degree of amount learned" and "excitement for next lab" ($p < 0.01$). The results of the post-lab quizzes for both blocks comparing the intervention (Anatomage) and control (dissection) groups, no difference was found between the two modalities in P/P; however, in MSK, the Anatomage group had a significantly higher average quiz score than the control group ($p = 0.03$). exam scores for

						the intervention (Anatomage) and control (dissection) groups in both the P/P and MSK anatomical regions, when comparing the results of the exam completed on the Anatomage table, the Anatomage group scored significantly higher than the dissection group ($p = 0.01$). However, when comparing the results of the cadaver practical exam, the dissection group scored significantly higher than the Anatomage group ($p = 0.04$). No significant difference was found when the mean exam scores of the Anatomage and cadaver practical exams were compared ($p = 0.83$). practical exam performance for both the Anatomage and control groups for MSK. No significant difference was found on the exam completed on the Anatomage table ($p = 0.39$). Similarly, no significant difference was found on the MSK cadaver practical exam between the two groups ($p = 0.47$). There was also no significant difference in the mean scores of the Anatomage and cadaver practical exams ($p = 0.41$).
Bhadoria, P. (2021). VIRTUAL DISSECTION–AS A NEW MEDICAL TEACHING TOOL. *European Journal of Biomedical*, *8*(4), 276-280.	Study type: Observational , Study design: Cross-sectional,	The aim of the study was to evaluate the impact of virtual dissection teaching techniques (VDTT) on first year MBBS students (Batch- 2019-20) in learning anatomy.	First-year MBBS students (n=92) (Batch-2019-20)	Marks obtained in monthly tests and an already validated questionnaire on Students Perceptions of VDTT	Pre-test and Post-test, questionnaire on Student’s perceptions of virtual dissection teaching techniques (VDTT)	Mean students' grades in monthly assessments before VDTT were 50.38±1.17(SE) and after VDTT were 56.94±1.18(SE). Mean marks significantly increased after the introduction of VDTT with P-value < 0.001. Students were classified into two groups: Good performers (scored marks ≥ 50) and Bad performers (scored marks <50). It was observed that out of 92 students, 45 were good performers and 47 were bad performers. Mean change in marks of good performers was 3.3±2.08 (SE) and in bad performers mean change in marks was 16±1.83(SE). Significant improvement in terms of marks obtained after the

						introduction of VDTT, was seen in bad performers with P-value < 0.001.
da Silveira, C. R., Miamoto Dias, P. E., Oenning, A. C., de Brito Junior, R. B., Turssi, C. P., & Oliveira, L. B. (2021). Digital anatomy table in teaching-learning process of the temporomandibular joint anatomy. *European Journal of Dental Education*.	A cross-sectional study.	The study aimed to evaluate the digital anatomy table in the teaching-learning process of the temporomandibular joint (TMJ) anatomy and the student's perception regarding this resource.	The study was conducted on 41 undergraduate dental students.	Knowledge, perception	Knowledge assessment test scores in theoretical class, practical class and digital table. Perception survey	When the teaching strategies were compared amongst each other, the medians of the scores with the digital anatomy table were significantly higher than after the theoretical and practical classes. At the end of the research, there were no differences amongst the three groups (theoretical class, practical class, and digital table). Regarding the perception, most of the students reported that the digital anatomy table helped them to understand the content of the theoretical class.
Anand, M. K., & Singel, T. C. (2014). A comparative study of learning with "anatomage" virtual dissection table versus traditional dissection method in neuroanatomy. *Ind J Clin Anat Physiol*, *4*, 177-180.	A randomized cross sectional prospective study	to compare the learning with "Anatomage" virtual dissection table versus learning with traditional dissection in neuroanatomy.	n = 122 1st year medical students were divided into two groups A and B. Group A studied "internal capsule, basal ganglion and spinal cord" by using "Anatomage" virtual dissection table. Group B learnt through the traditional dissection method. P	anatomage virtual dissection table, students' perception	Pre and post-tests were conducted for all groups with a pre validated questionnaire. Feedback was obtained from students through a 5-point Likert scale. Students' t test was applied for statistical analysis.	There was no statistically significant difference in gain of knowledge in group A students in comparison to group B students. 51% students found that use of "Anatomage" virtual dissection table helped them understand topic better and majority (79%) felt that it enhanced their classroom experience.

Custer, T. M., & Michael, K. (2015). The utilization of the Anatomage virtual dissection table in the education of imaging science students. *Journal of Tomography & Simulation, 1*.	qualitative, single-site case study	The purpose of this research was to investigate the use of the Anatomage Virtual Dissection Table in the education of imaging science students and to assess the beliefs and perceptions of the students regarding using the Table for teaching imaging-based anatomy and pathology	n= 17 medical imaging science post primary program students	Anatomage table, students' perception	Focus group and interview questions based on previous experience and knowledge. All focus group sessions were audiotaped, transcribed and reviewed by the researchers for data analysis.	Data gathered over time from the focus groups was positive. By mid-semester, 82% of the students felt the Anatomage Table was beneficial to their learning. This number rose to 88% by the end of the semester, and almost achieved 100% by the end of the study with one student remaining undecided
Kausar, T., Chandio, S., Quddus, I., Qureshi, G. S., Baloch, Z. H., & Pario, A. (2020). Effectiveness of Teaching with Visualisation Table in Comparison to Traditional Lecture in Anatomy Department, Jinnah Sindh Medical University. *Medical Education*	Cross-sectional study	To determine the effectiveness of Sectra visualization table (SVT) in a public sector setup and to compare the traditional (TRAD) lecture with SVT-aided teaching in terms of learning outcomes and students' perception regarding SVT.	Bachelor of Dental Surgery (BDS) students n= 50 students were randomly distributed in TRAD and SVT groups, both were exposed to 3 sessions of 1-hour duration. TRAD group attended lecture sessions, whereas SVT group were exposed to SVT-aided teaching	Visualization table, traditional lecture, test scores,	VAK questionnaire, multiple choice question (MCQ) Test	Scores of MCQs test between the groups showed non-significant difference ($p = 0.24$). Positive feedback was obtained in favor of SVT. Students of SVT group exposed to visual style of learning performed better.
Whited, T. M., DeClerk, L., Berber, A., & Phelan, K. D. (2021). An innovative	pretest/posttest design	The purpose of this evaluation was to determine if teaching with a computed tomography (CT)-based three-dimensional (3D)	17 students enrolled in a graduate level Health	self-rate confidence in knowledge of pediatric anatomy for each body system, self-	Presurvey and post surveys, A 5-point Likert scale	Pretest self-rated confidence in anatomy knowledge ranged from three to five in HEENT, and two to four in other systems. Most students rated themselves as four on HEENT, abdominal, and skin assessment. Posttests show self-ratings of four or five on

technique to promote understanding of anatomy for nurse practitioner students. *Journal of the American Association of Nurse Practitioners*, *33*(5), 348-352.		anatomy table and cadaveric specimens improves Doctor of Nursing Practice (DNP) and NP students' understanding of anatomy in health assessment.	Assessment course.	perceived, overall knowledge of human anatomy, perceived benefit of the anatomy table on overall anatomy knowledge and physical assessment skills.		all systems, except for one student selecting a rating of three for the nervous system. Mean scores for self-rating knowledge per body system increased. Analysis using Mann–Whitney U test demonstrated a statistically significant difference in distribution of scores for heart and lung, abdomen, muscular–skeletal, skin, and nervous systems between pre-assessment and post-assessment surveys.
Bianchi, S., Bernardi, S., Perilli, E., Cipollone, C., Di Biasi, J., & Macchiarelli, G. (2020). Evaluation of effectiveness of digital technologies during anatomy learning in nursing school. *Applied Sciences*, *10*(7), 2357.	cross-sectional study	The aim of the study was to test the use of a virtual dissection table (DT) during the anatomy lectures of a nursing course, evaluating the anxiety level before the exam and evaluating the exam score.	133 first year nursing school students.	Anxiety level, exam score, perception.	perception questionnaire, State-Trait Anxiety Inventory (STAI) test, anatomy exam	100% of students judged satisfying or very satisfying their degree of interest in the subject of the course (A), 95% percent of students perceived satisfying their level of interactivity during the lesson (B). The total of students judged satisfying or very satisfying the fulfillment of their initial expectation regarding the training contents (C). 100% of students appreciated the different teaching methods, giving satisfying or very satisfying scores (D). 98% of students scored satisfying or very satisfying. The adequacy in terms of function and comfort of the dedicated teaching room (E). 100% of students scored as satisfying or very satisfying the quality of the DT, paying particular attention to the completeness of contents and useful application in their nursing education (F). 37% of students scored as satisfying or very satisfying the interface of the anatomical table (G). The total of students scored as satisfying or very satisfying the final level of their own anatomical knowledge (H). The total of the students considered the strengths of these different teaching methods superior with respect to the limitations (I) and the total of them would suggest to a colleague to follow similar courses with this type of teaching

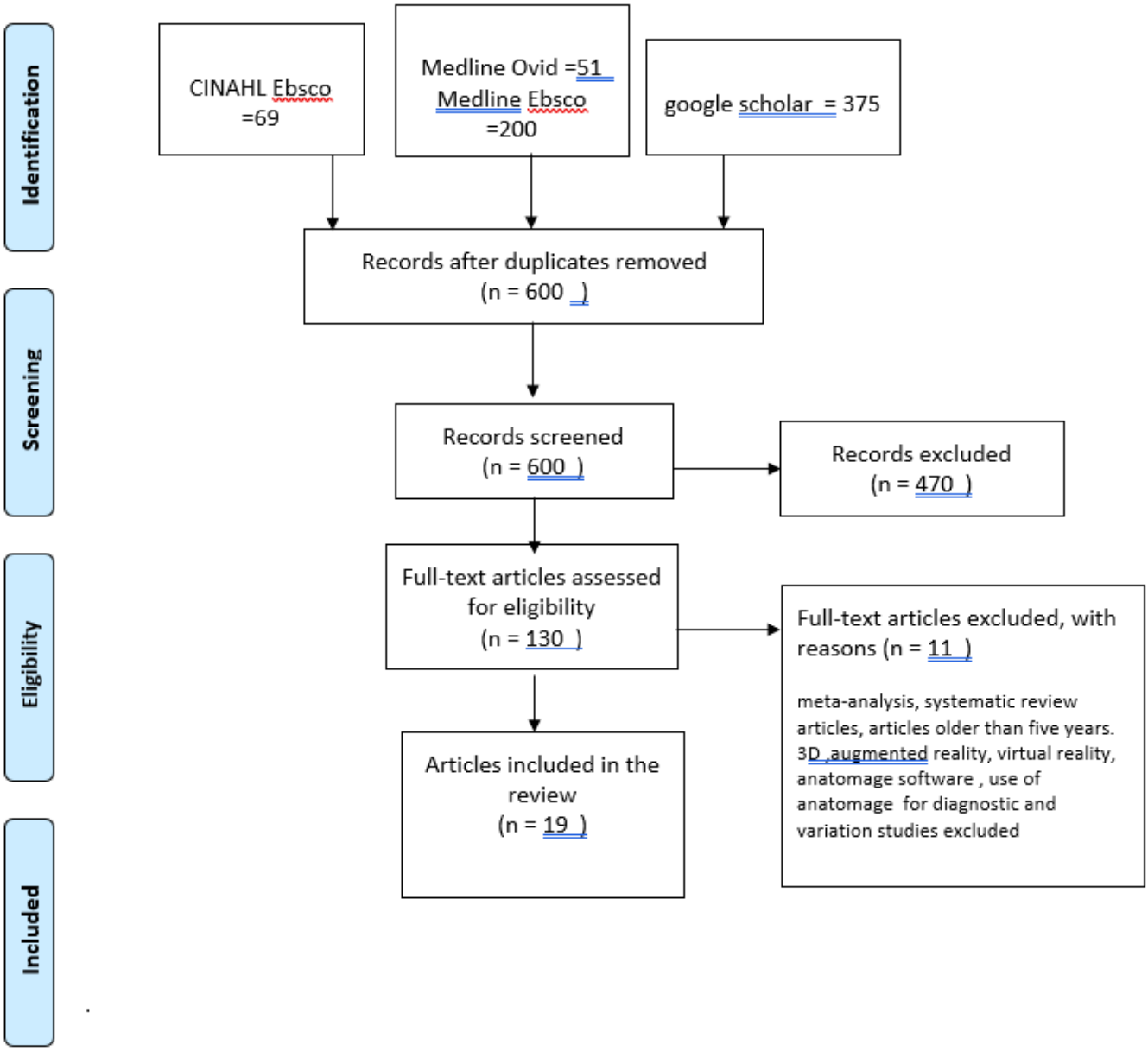
						approach (J). The STAI mean values of the group of students who attended the DT laboratory session were significantly lower compared to the students who only attended the mandatory lectures.
Kazoka, D., & Pilmane, M. COMBINATION OF NEW, INNOVATIVE AND DEMONSTRATIVE 3D ELEMENTS WITH CLASSICAL LEARNING METHODS IN HUMAN ANATOMY COURSE.	Cross sectional?	This work's aim was to study, compare and summarize our experience in combination of innovative and demonstrative 3D elements with classical learning methods in Human Anatomy course.	100 1st year medical school, and 100 student's 2nd year medical school n= 200	an anonymous feedback questionnaire	virtual dissection anatomage table, 3D printed anatomical models, classical human cadaveric dissections, students' satisfaction	In learning of structures 70% of the students were satisfied with the virtual dissection and/or their own prepared anatomical 3D models in group 1, but they liked to highlight the role and necessity of real dissection. 42.25% thought use of only virtual dissection Anatomage Table was enough to teach and study anatomy. 24.75% of students liked anatomy with prepared and printed 3D anatomical models. Some students were satisfied with the classical learning and teaching of Human Anatomy course when associated it with the use of different new, innovative and demonstrative 3D elements. Majority of students (90%) considered that virtual elements and models were useful in learning the study course outside the practical classes. In group 2 more than 95% of participants indicated that dissection anatomy should be regular and available to all students. Almost all students mentioned that dissections provided the real touch feeling of human body. In group 2 classical learning of anatomical structures obtained better results than only in the innovations supported group. When asked about necessity of advantages of dissection method, 96.23% of students indicated that it is necessary to become specialists in medicine, while 92.45% students marked that it is important for better understanding of clinical and surgical cases. Regarding possible combinations of methods in teaching and learning anatomy in both

						groups, all students were asked about different variants of used methods as well as other methods (computer aided learning, plastinates, CT scans, imaging techniques). In both groups the large number of students gave preference to combination of real and virtual dissection, and printed 3D models (Fig. 1). In group 2 this combination was marked by 50.31% students, while in group 1 it was appreciated by 45.31% students. The need for increasing only real and virtual dissection methods was indicated by 32.14% students in group 2, while the need for dissection and printed 3D models' combination was preferred by 24.75% students in group 1. Regarding possible combination with other methods in Human Anatomy course, only 4.78% and 7.23% students mentioned them in group 1 and group 2 respectively. When asked about other methods or improvements for methods in Human Anatomy course, students of both groups gave preference to the use of imaging techniques (radiological anatomy) and the use of CT scans (30.08% and 25.80%). Only 20.45% of students mentioned the use of computer aided learning. 20.45% of students indicated the use of plastinates. Comparison of students` perception scores of acquiring anatomical knowledge, using different learning methods in Human Anatomy course, demonstrated that classical method (dissection) was the best method for better level of knowledge, motivation of learning, identification of anatomical structures and their understanding. New innovations (virtual dissection and printed models) helped 44.62% of students identify and understand anatomical structures. 39.24% of

						students reported that these methods were useful for better level of knowledge. It was found that the use of only one method of printed models received the least score (11.12%) in motivation of learning

Appendix B

PRISMA 2009 Flow Diagram

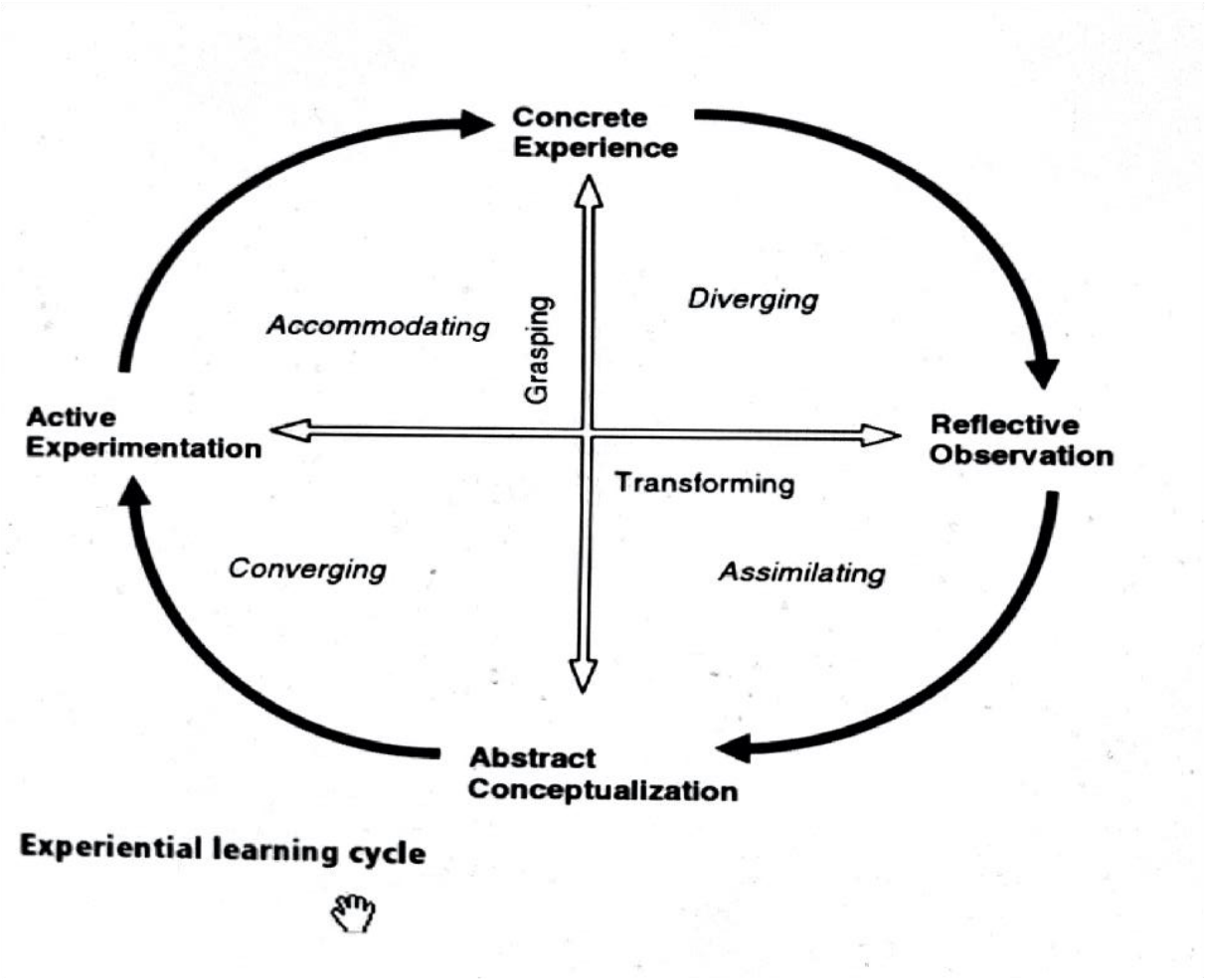


From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). *P*referred *R*eporting *I*tems for *S*ystematic Reviews and *M*eta-*A*nalyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097

For more information, visit www.prisma-statement.org

Appendix C

Kolb's Experiential learning theory



Kolb & Kolb, (2009)

Appendix D

SWOT Analysis	
Strengths	**Weaknesses**
•Technology based, easy to build excitement and engage millennial learners. •The project site consists of a workforce dedicated to the success of the project. •The project site's communication center is equipped with a speaking and film studio which will help facilitate the creation of the simulation videos. •The presence of a culture of growth and continuous improvement that fosters evidence-based practice and research. •A new and fully functional Anatomage table at project site. •Access to a canvas published Anatomage table training modules. •A Project team which consists of a seasoned anatomy professor with an extensive knowledge of the Anatomage table and another with extensive research study experience with numerous publications.	•Only have one Anatomage table which is shared amongst all the healthsciences. •Limited access to the Anatomage table to participants to practice the simulated interventions. •Time constraints to develop, implement and disseminate project.
Opportunities	**Threats**
• Access to Anatomage training resources. • Large reputable organization with affiliations and resources to acquire additional Anatomage tables specifically for the anesthesia program. • Strengthening of the CRNA curriculum and students' knowledge to providing exceptional patient care in the community applying the knowledge and skins acquired from Anatomage training.	•COVID-19 flares and program moving more towards online learning. •Students time constraint due to rigorous program and course work •Lack of interest in student participation •Lack of faculty training and interest •Housing the Anatomage table and finding a good fit for it within an already full curriculum in place.

Appendix E

Pre and post-test questions

1. What are the 3 paired cartilages of the Larynx?
2. What are the 3 non-paired cartilages of the Larynx?
3. Name 3 cranial nerves that innervate the airway.
4. Match the following laryngeal muscles with the nerve that innervates it.

Laryngeal muscle	Nerve innervated.
- Cricothyroid	Superior Laryngeal Nerve
- Vocalis	Recurrent Laryngeal nerve
- Thyroarytenoids	
- Lateral cricoarytenoid	
- Posterior Cricoarytenoid	

5. Match the following laryngeal muscles with the muscular action on the vocal cords.

Cricothyroid	tenses
- Vocalis	relaxes
- Thyroarytenoids	adducts
- Lateral cricoarytenoids	abducts
- Posterior cricoarytenoids	

Appendix F

Open-Ended Questionnaire

1. In what ways they felt the knowledge gained from the utilization of the AT would be helpful in their clinical and future practice as a CRNA

2. In what ways was the AT laboratory experience beneficial or not to their understanding of airway anatomy and innervation and lastly,

3. In what does the AT compared to prior methods utilized to learn airway anatomy. A total of 33 participants were involved in this DNP project.

Appendix G

Anatomical Self-Efficacy Instrument

SELF-EFFICACY--*Please CIRCLE the number that applies.*

The answers to these questions can be the following:

1—If you are **not at all** confident that you can do the task.
2—If you are **only a little** confident that you can do the task.
3—If you are **fairly** confident that you can do the task.
4—If you are **very** confident that you can do the task.
5—If you are **totally** confident that you can do the task.

	Not at All	Only a Little	Fairly	Very	Totally
1) I am confident that I can make the proper cuts in the cadaver as outlined in the lab manual.	1	2	3	4	5
2) I am confident that I can successfully answer questions from the professors **during dissection laboratories**.	1	2	3	4	5
3) I am confident that I can use dissection tools.	1	2	3	4	5
4) I am confident that I can successfully complete the dissections.	1	2	3	4	5
5) I am confident that I can correctly pronounce anatomical terms.	1	2	3	4	5
6) I am confident that I can learn anatomical relationships (i.e. how one item relates to another in position in the body).	1	2	3	4	5
7) I am confident that I can learn anatomical terms and definitions.	1	2	3	4	5
8) I am confident that I can perform successfully on the anatomy course **written** exams.	1	2	3	4	5
9) I am confident that I can perform successfully on the anatomy course **lab practical** exams.	1	2	3	4	5
10) I am confident that I will be able to retain and recall anatomical knowledge **for use in a clinical setting**.	1	2	3	4	5
11) I am confident that I can actively participate in anatomical discussions **with the professors in the dissection laboratories**.	1	2	3	4	5
12) I am confident that I can locate anatomical structures in the human cadaver.	1	2	3	4	5
13) I am confident that I can identify anatomical abnormalities in the human cadaver.	1	2	3	4	5
14) I am confident that I can describe anatomical structures to a **non-medical** person.	1	2	3	4	5
15) I am confident that I can successfully answer **anatomical-based** questions **during clinical rotations**.	1	2	3	4	5
16) I am confident that I can learn the anatomical content of this anatomy course.	1	2	3	4	5

(Burgoon et al., 2012)

Appendix H

PNB Self-Efficacy Survey

Self-Efficacy ---Please Circle the number that applies.

The answers to these questions can be the following:

1---If you are Not at All that you can do the task

2---If you are Only a Little confident that you can do the task

3---If you are Fairly confident that you can do the task

4---If you are Very confident that you can do the task

5---If you are Totally confident that you can do the task

	Not at All	Only a Little	Fairly	Very	Totally
1) I am confident that I can identify Interscalene block anatomy on the anatomage table.	1	2	3	4	5
2) I am confident that I can answer questions on Interscalene block anatomy.	1	2	3	4	5
3) I am confident that I can use anatomage table to learn Interscalene block anatomy.	1	2	3	4	5
4) I am confident that I can identify internal structures related to Interscalene block.	1	2	3	4	5
5) I am confident that I can correctly pronounce Interscalene block anatomical terms.	1	2	3	4	5
6) I am confident at identifying Interscalene block anatomical relationships.	1	2	3	4	5
7) I am confident at identifying Interscalene block surgical indications and coverage.	1	2	3	4	5
8) I am confident that I can answer questions pertaining to the interscalene block successfully on the course written exams.	1	2	3	4	5
9) I am confident that I can perform successfully during test out over the Interscalene block during course lab practical exams.	1	2	3	4	5
10) I am confident that I will be able to retain and recall anatomical knowledge for use in a clinical setting.	1	2	3	4	5

11) I am confident that I can actively participate in Interscalene block anatomical discussions with the professors in the skills lab utilizing the anatomage table.	1	2	3	4	5
12) I am confident that I can locate anatomical structures on a patient in a clinical setting.	1	2	3	4	5
13) I am confident that I can identify anatomical abnormalities on a patient in a clinical setting	1	2	3	4	5
14) I am confident that I can describe Interscalene block anatomical structures to a non-medical person.	1	2	3	4	5
15) I am confident that I can successfully answer Interscalene block anatomical-based questions during clinical rotations.	1	2	3	4	5
16) I am confident that I can learn the Interscalene block anatomical content of this course.	1	2	3	4	5

Appendix I

Laryngeal airway anatomy and nerve innervation Simulation

Self-Efficacy survey

Self-Efficacy ---Please Circle the number that applies.

The answers to these questions can be the following:

1---If you are Not at All that you can do the task

2---If you are Only a Little confident that you can do the task

3---If you are Fairly confident that you can do the task

4---If you are Very confident that you can do the task

5---If you are Totally confident that you can do the task

	Not at All	**Only a Little**	**Fairly**	**Very**	**Totally**
1) I am confident that I can identify laryngeal structures on the anatomage table.	1	2	3	4	5
2) I am confident that I can answer questions on laryngeal anatomy.	1	2	3	4	5
3) I am confident that I can use anatomage table to learn airway anatomy.	1	2	3	4	5
4) I am confident that I can identify airway innervation.	1	2	3	4	5
5) I am confident that I can correctly pronounce airway anatomical terms.	1	2	3	4	5
6) I am confident that I can learn airway anatomical relationships.	1	2	3	4	5
7) I am confident that I can learn airway anatomical terms and functions.	1	2	3	4	5
8) I am confident that I can perform successfully on the airway anatomy course written exams.	1	2	3	4	5

9) I am confident that I can perform successfully on the airway anatomy course lab	1	2	3	4	5
10) I am confident that I will be able to retain and recall anatomical knowledge for use in a clinical setting.	1	2	3	4	5
11) I am confident that I can actively participate in airway anatomical discussions with the professors in the skills lab utilizing the anatomage table.	1	2	3	4	5
12) I am confident that I can locate anatomical structures in the human cadaver	1	2	3	4	5
13) I am confident that I can identify airway anatomical abnormalities in the human cadaver.	1	2	3	4	5
14) I am confident that I can describe airway anatomical structures to a non-medical person.	1	2	3	4	5
15) I am confident that I can successfully answer airway anatomical-based questions during clinical rotations.	1	2	3	4	5
16) I am confident that I can learn the airway anatomical content of this course	1	2	3	4	5

Appendix J

MARIAN UNIVERSITY
Indianapolis ®

Institutional Review Board

DATE:	2-21-2022
TO:	Precious Hogo, Chidimma Offiah, Dr. Summerlin-Grady, Dr. Erica Asuel
FROM:	Institutional Review Board
RE:	S22.109
TITLE:	Antomage Table and Effects on Improving Clinical Anatomy Knowledge and Competence in Anesthesia Procedures and Assessment
SUBMISSION TYPE:	New Project
ACTION:	Determination of EXEMPT Status
DECISION DATE:	2-21-2022

The Institutional Review Board at Marian University has reviewed your protocol and has determined the procedures proposed are appropriate for exemption under the federal regulations. 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. Please be mindful of the importance of reporting only de-identified, HIPPA-compliant information about the patient in any exhibit or publication.

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.

Appendix K

Laryngeal airway anatomy and nerve innervation Simulation Self-Efficacy posttest survey questions.

Frequencies for Q1

Q1	Frequency	Percent	Valid Percent	Cumulative Percent
4	15	45.455	45.455	45.455
5	5	15.152	15.152	60.606
2	1	3.03	3.03	63.636
3	12	36.364	36.364	100
Missing	0	0		
Total	33	100		

Frequencies for Q2

Q2	Frequency	Percent	Valid Percent	Cumulative Percent
4	19	57.576	57.576	57.576
5	2	6.061	6.061	63.636
2	2	6.061	6.061	69.697
3	10	30.303	30.303	100
Missing	0	0		
Total	33	100		

Frequencies for Q3

Q3	Frequency	Percent	Valid Percent	Cumulative Percent
3	7	21.212	21.212	21.212
4	18	54.545	54.545	75.758
5	8	24.242	24.242	100
Missing	0	0		
Total	33	100		

Frequencies for Q4

Q4	Frequency	Percent	Valid Percent	Cumulative Percent
4	19	57.576	57.576	57.576
5	2	6.061	6.061	63.636
2	1	3.03	3.03	66.667
3	11	33.333	33.333	100
Missing	0	0		
Total	33	100		

Frequencies for Q5

Q5	Frequency	Percent	Valid Percent	Cumulative Percent
3	7	21.212	21.212	21.212
4	18	54.545	54.545	75.758
5	8	24.242	24.242	100
Missing	0	0		
Total	33	100		

Frequencies for Q6

Q6	Frequency	Percent	Valid Percent	Cumulative Percent
3	8	24.242	24.242	24.242
4	21	63.636	63.636	87.879
5	4	12.121	12.121	100
Missing	0	0		
Total	33	100		

Frequencies for Q7

Q7	Frequency	Percent	Valid Percent	Cumulative Percent
3	8	24.242	24.242	24.242
4	19	57.576	57.576	81.818
5	6	18.182	18.182	100
Missing	0	0		

Total	33	100

Frequencies for Q8

Q8	Frequency	Percent	Valid Percent	Cumulative Percent
3	8	24.242	24.242	24.242
4	17	51.515	51.515	75.758
5	6	18.182	18.182	93.939
2	2	6.061	6.061	100
Missing	0	0		
Total	33	100		

Frequencies for Q9

Q9	Frequency	Percent	Valid Percent	Cumulative Percent
3	11	33.333	33.333	33.333
4	17	51.515	51.515	84.848
5	4	12.121	12.121	96.97
2	1	3.03	3.03	100
Missing	0	0		
Total	33	100		

Frequencies for Q10

Q10	Frequency	Percent	Valid Percent	Cumulative Percent
4	19	57.576	57.576	57.576
5	4	12.121	12.121	69.697
2	1	3.03	3.03	72.727
3	9	27.273	27.273	100
Missing	0	0		
Total	33	100		

Frequencies for Q11

Q11	Frequency	Percent	Valid Percent	Cumulative Percent
4	19	57.576	57.576	57.576
5	7	21.212	21.212	78.788
2	1	3.03	3.03	81.818
3	6	18.182	18.182	100
Missing	0	0		
Total	33	100		

Frequencies for Q12

Q12	Frequency	Percent	Valid Percent	Cumulative Percent
3	12	36.364	36.364	36.364
4	16	48.485	48.485	84.848
5	3	9.091	9.091	93.939
1	2	6.061	6.061	100
Missing	0	0		
Total	33	100		

Frequencies for Q13

Q13	Frequency	Percent	Valid Percent	Cumulative Percent
2	3	9.091	9.091	9.091
3	15	45.455	45.455	54.545
4	11	33.333	33.333	87.879
5	3	9.091	9.091	96.97
1	1	3.03	3.03	100
Missing	0	0		
Total	33	100		

Frequencies for Q14

Q14	Frequency	Percent	Valid Percent	Cumulative Percent
3	9	27.273	27.273	27.273

4	19	57.576	57.576	84.848
5	4	12.121	12.121	96.97
2	1	3.03	3.03	100
Missing	0	0		
Total	33	100		

Frequencies for Q15

Q15	Frequency	Percent	Valid Percent	Cumulative Percent
3	11	33.333	33.333	33.333
4	18	54.545	54.545	87.879
5	3	9.091	9.091	96.97
2	1	3.03	3.03	100
Missing	0	0		
Total	33	100		

Frequencies for Q16

Q16	Frequency	Percent	Valid Percent	Cumulative Percent
4	19	57.576	57.576	57.576
5	5	15.152	15.152	72.727
3	9	27.273	27.273	100
Missing	0	0		
Total	33	100		

Appendix L

Table 8

Frequency Tables

PNB Self-efficacy survey questions

Frequencies for Q1

Q1	Frequency	Percent	Valid Percent	Cumulative Percent
4	5	41.667	41.667	41.667
5	7	58.333	58.333	100.000
Missing	0	0.000		
Total	12	100.000		

Frequencies for Q2

Q2	Frequency	Percent	Valid Percent	Cumulative Percent
4	5	41.667	41.667	41.667
5	7	58.333	58.333	100.000
Missing	0	0.000		
Total	12	100.000		

Frequencies for Q3

Q3	Frequency	Percent	Valid Percent	Cumulative Percent
3	1	8.333	8.333	8.333
4	5	41.667	41.667	50.000
5	6	50.000	50.000	100.000

Frequencies for Q3

Q3	Frequency	Percent	Valid Percent	Cumulative Percent
Missing	0	0.000		
Total	12	100.000		

Frequencies for Q4

Q4	Frequency	Percent	Valid Percent	Cumulative Percent
4	5	41.667	41.667	41.667
5	7	58.333	58.333	100.000
Missing	0	0.000		
Total	12	100.000		

Frequencies for Q5

Q5	Frequency	Percent	Valid Percent	Cumulative Percent
3	2	16.667	16.667	16.667
4	3	25.000	25.000	41.667
5	7	58.333	58.333	100.000
Missing	0	0.000		
Total	12	100.000		

Frequencies for Q6

Q6	Frequency	Percent	Valid Percent	Cumulative Percent
3	2	16.667	16.667	16.667

Frequencies for Q5

Q5	Frequency	Percent	Valid Percent	Cumulative Percent
4	6	50.000	50.000	66.667
5	4	33.333	33.333	100.000
Missing	0	0.000		
Total	12	100.000		

Frequencies for Q7

Q7	Frequency	Percent	Valid Percent	Cumulative Percent
3	1	8.333	8.333	8.333
4	5	41.667	41.667	50.000
5	6	50.000	50.000	100.000
Missing	0	0.000		
Total	12	100.000		

Frequencies for Q8

Q8	Frequency	Percent	Valid Percent	Cumulative Percent
3	1	8.333	8.333	8.333
4	6	50.000	50.000	58.333
5	5	41.667	41.667	100.000
Missing	0	0.000		
Total	12	100.000		

Frequencies for Q9

Q9	Frequency	Percent	Valid Percent	Cumulative Percent
3	1	8.333	8.333	8.333
4	4	33.333	33.333	41.667
5	7	58.333	58.333	100.000
Missing	0	0.000		
Total	12	100.000		

Frequencies for Q10

Q10	Frequency	Percent	Valid Percent	Cumulative Percent
4	7	58.333	58.333	58.333
5	5	41.667	41.667	100.000
Missing	0	0.000		
Total	12	100.000		

Frequencies for Q11

Q11	Frequency	Percent	Valid Percent	Cumulative Percent
4	7	58.333	58.333	58.333
5	5	41.667	41.667	100.000
Missing	0	0.000		
Total	12	100.000		

Frequencies for Q12

Frequencies for Q11

Q11	Frequency	Percent	Valid Percent	Cumulative Percent
Q12	**Frequency**	**Percent**	**Valid Percent**	**Cumulative Percent**
3	2	16.667	16.667	16.667
4	3	25.000	25.000	41.667
5	7	58.333	58.333	100.000
Missing	0	0.000		
Total	12	100.000		

Frequencies for Q13

Q13	Frequency	Percent	Valid Percent	Cumulative Percent
2	1	8.333	8.333	8.333
3	5	41.667	41.667	50.000
4	4	33.333	33.333	83.333
5	2	16.667	16.667	100.000
Missing	0	0.000		
Total	12	100.000		

Frequencies for Q14

Q14	Frequency	Percent	Valid Percent	Cumulative Percent
3	2	16.667	16.667	16.667
4	7	58.333	58.333	75.000
5	3	25.000	25.000	100.000
Missing	0	0.000		

Frequencies for Q13

Q13	Frequency	Percent	Valid Percent	Cumulative Percent
Total	12	100.000		

Frequencies for Q15

Q15	Frequency	Percent	Valid Percent	Cumulative Percent
3	2	16.667	16.667	16.667
4	6	50.000	50.000	66.667
5	4	33.333	33.333	100.000
Missing	0	0.000		
Total	12	100.000		

Frequencies for Q16

Q16	Frequency	Percent	Valid Percent	Cumulative Percent
4	5	41.667	41.667	41.667
5	7	58.333	58.333	100.000
Missing	0	0.000		
Total	12	100.000		