INSTRUCTIONAL DESIGN, IMPLEMENTATION STRATEGIES, AND EVALUATION OF ANES 525 APPLIED ANATOMY FOR ANESTHESIA PRACTICE: TRANSFORMATION OF A DISSECTION-BASED BASIC SCIENCE COURSE INTO A TECHNOLOGY AND CLINICALLY BASED ANATOMY COURSE FOR ANESTHESIOLOGIST ASSISTANT STUDENTS

by

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Abstract

Due to perceived economic drain on Emory University Anesthesiologist Assistant (AA) Program resources, faculty, and students, administrators called for the anatomy course to eliminate cadaver laboratory. Simultaneously, administrators encouraged faculty to design AA courses with regard to the progressive medical education pedagogic transition from traditional lecture hall dissemination of information toward experiential learning via problem-based learning (PBL) and authentic activities. Additionally, progressive medical educators advocate for inclusion of medical technology in both clinical and didactic learning environments. So although dissection of cadavers has historically been the cornerstone of anatomy instruction, advancements in medical imaging, virtual cadaver software, and digital learning media suggest that a flipped and blended course of human anatomy is possible. This study documents the transformation of a graduate level dissection-based basic science course into a technology and clinically based anatomy course. Student achievement measured via pre/posttest design demonstrated significant increases in scores, which indicates that learning occurred. Student perceptions of teaching and learning materials and instructional methods measured by a Likert-type survey questionnaire revealed learning preferences and attitudes, and showed significant correlations between key questions to support instrument validity.

Keywords: anesthesiologist assistant, medical education, anatomy, instructional design, online teaching and learning, flipped classroom, brain targeted teaching, PBL, authentic activities, constructivism, student achievement, student perceptions, ALE

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Acknowledgements

Having worked as an Anesthesiologist Assistant (AA) in the operating rooms of Emory University Hospital Midtown for over fifteen years, I was familiar with clinical education of AA students. More recently, teaching in the didactic portion of the Emory AA program, I became concerned with my lack of knowledge of foundational education theory, pedagogy, instructional design, and evidence-based best practices. Correspondingly, I felt an escalating responsibility to provide quality instructional experiences and educational opportunities to my students. Three years ago, I refocused my lifelong learning toward education, and began my doctoral journey at Johns Hopkins.

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Chapter 1: Introduction

Due to perceived economic drain on the resources, instructors, and students of the Emory University School of Medicine Master of Medical Science in Anesthesiology Program (hereinafter referred to as the *EUAAP*), administrators have called for the human anatomy course to eliminate the cadaver laboratory. Simultaneously, administrators are encouraging didactic faculty to align courses with progressive medical education pedagogy. Medical education is in flux with regard to a pedagogical transition from traditional lecture hall dissemination of information toward experiential learning via authentic activities. Additionally, medical education continuously seeks to include advances in medical technology in both didactic and clinical learning environments. Advancements in medical imaging, virtual cadaver software, and digital learning media suggest that a blended course for human anatomy may be possible with elimination of cadaver laboratory and face-to-face lectures and inclusion of digital media and authentic activities.

This study examined the literature from the perspectives of the problem and stakeholders, conducted a needs assessment of EUAPP, examined the literature from the perspective of probable interventions, utilized the ADDIE model to guide instructional design of the course transformation, implemented the intervention, collected, and examined the effectiveness of the intervention. Results, likely explanations, limitations and constraints, future implications for course transformation, and applicability of the intervention for other programs of medical education conclude the report. The newest RQ is: In what ways will results from this two and a half year study positively affect future iterations of the AA anatomy course? Answering it begins with the primary POP.

Problem of Practice

My observed problem of practice is administrators' mandated changes to the EUAAP curriculum and courses. In order to address the problem as course director, instructional designer, and instructor, I need to transform BAHS 500 Human Anatomy with Cadaver Laboratory, a dissection-based basic science course, into a technology and clinically based anatomy course for anesthesiologist assistant students, ANES 525 Applied Anatomy for Anesthesia Practice.

As set by EUAAP directors, the goals for redesign of BAHS 500 Human Anatomy with Cadaver Laboratory are to: (a) decrease credit hours from 3 to 2; (b) decrease cost and time constraints associated with dissection by eliminating cadaver laboratory; (c) increase use of technology and medical images; (d) incorporate clinical content of applied anatomy relevant to anesthesia practice; and (e) utilize progressive medical education pedagogy. The new course ANES 525 Applied Anatomy for Anesthesia Practice aims to: (a) help the student construct knowledge of anatomy as applied to anesthesia practice, as preparation for more specialized courses in the field; (b) help the student develop clinical skills (i.e., cognitive, psychomotor, affective, and communication) required of anesthesia providers; and (c) develop the ability of the student to transfer acquired knowledge and skills to the clinical environment.

Purpose of the Study

The purpose of this study is to describe the course redesign as the intervention, describe instructional strategies used during implementation, and investigate learning outcomes, student perceptions, and instructor participation. To provide students adequate opportunities to learn, the course director, instructional designer, and instructor will collaborate to design, develop, and implement the course. Specifically, instructional design (ID) choices surrounding instructional strategies, such as teaching and learning materials (TLM) and instructional methods germane to medical education, clinical anatomy, and anesthesia practice will be identified, assessed, and incorporated. Background research to deeply understand the problem, identification of probable interventions, identification of probable implementation methods, and guiding theories and models will inform the course redesign.

Chapter 2: The Paradigm Shift in Medical Education and Anatomy Curricula

From Cadavers to Computers: A Literature Review of Historical and Progressive Course Design, Pedagogies, and Teaching and Learning Materials

The study of anatomy in medical education curricula is changing from traditional cadaver based dissection courses toward plastinated specimens and digital media. With the ubiquitous presence of computers in the classroom and clinic, the availability and quality of virtual learning materials have challenged the long-standing reliance on cadaveric tissue as the primary learning material. Concurrently, medical education is undergoing a pedagogical transition from teacher-centered teaching toward student-centered teaching and applied learning methodologies. This literature review examines the history of human dissection as the cornerstone of anatomy curricula, associated economic issues, current teaching and learning materials (TLM), and current instructional methods in various medical anatomy courses.

Contextual Framework

To begin the discussion on medical education of anesthesiologist assistants, the following three aspects need to be reviewed: (a) a general overview of the profession; (b) a description of the EUAAP; and (c) specifics of the current anatomy course are discussed to create a foundation for establishing the Problem of Practice.

Overview of the Anesthesiologist Assistant Profession

Anesthesiologist assistants (AAs) are allied health care practitioners that work under the medical direction of physician anesthesiologists. Established at Emory University in 1969, the AA profession is modeled after the physician assistant profession (Steinhaus, Evans, & Frazier, 1973). AAs are similar in education and training to general physician assistants (PAs), but exclusively practice as specialists in the field of anesthesiology. The AA scope of practice is very similar to nurse anesthetists (NAs). Within the Centers for Medicare & Medicaid Services section of the Code of Federal Regulations, AAs and NAs are defined as *non-physician anesthetists* (American Academy of Anesthesiologist Assistants [AAAA], 2013, Basic Definitions & Information, para. 1). Collectively, these non-physician practitioners are commonly referred to as *physician extenders, mid-level providers,* or *advanced practice providers*.

The national professional society for AAs, the American Academy of Anesthesiologist Assistants (AAAA), gives a more detailed description:

> Anesthesiologist assistants (AAs) are highly skilled health professionals who work under the direction of licensed anesthesiologists to implement anesthesia care plans. AAs work exclusively within the anesthesia care team environment as described by the American Society of Anesthesiologists (ASA). All AAs possess a premedical background, a baccalaureate degree, and also complete a comprehensive didactic and clinical program at the graduate school level. AAs are trained extensively in the delivery and maintenance of quality anesthesia care as well as advanced patient monitoring techniques. The goal of AA education is to guide the transformation of qualified student applicants into competent health care practitioners who aspire to practice in the anesthesia care team. (AAAA, 2013, Basic Definitions & Information, para. 1)

A typical job description, defined scope of clinical practice, and supplemental information are available on the AAAA website (AAAA, 2013, AA Practice, para. 3).

Anesthesiologist Assistant Education

Programmatic accreditation of medical field disciplines serves an important public interest by informing on the qualifications of healthcare providers (Commission on Accreditation of Allied Health Education Programs [CAAHEP], 2009, About Accreditation, para. 5).

> AA training programs must include a minimum of 24-28 months in a Master's level program accredited by the Commission on Accreditation of Allied Health Education Programs (CAAHEP). The programs must be based at, or in collaboration with, a university that has a medical school and academic anesthesiologist physician faculty. Each AA program must have at least one director that is a licensed, board-certified anesthesiologist. Main clinical sites must be academic medical centers. An average of 600 hours of classroom/laboratory education, 2600 hours of clinical anesthesia education, and more than 600 anesthetics administered, including all types of surgery, are typically required to successfully complete AA training. (AAAA, 2013, Basic Definitions & Information, para. 4)

The Standards and Guidelines for Accreditation of Anesthesiologist Assistant Education Programs and supporting documents are available on the (CAAHEP, 2009, Standards and Guidelines, AA).

Anesthesiologist Assistant Certification

Like accreditation, certification also serves an important public interest by informing on the qualifications of healthcare providers. The National Commission for Certification of Anesthesiologist Assistants (NCCAA) "charter includes assuring the public that certified anesthesiologist assistants (CAAs) meet basic standards related to fund of knowledge and application of that knowledge to the duties of practicing as an anesthesiologist assistant" (National Commission for Certification of Anesthesiologist Assistants [NCCAA], 2009b, homepage, para. 2).

> Upon completion of an accredited AA program, a student may become certified by passing the NCCAA examination. The examination is administered and scored by the National Board of Medical Examiners as part of services contracted to NCCAA. . . NCCAA awards a time-limited certificate to each candidate who successfully completes the Certifying Examination. To re-certify, an AA must complete 40 hours of CME every two years and register the activities with NCCAA. Additionally, AAs must take the Continuing Demonstration of Qualification Exam every six years. (AAAA, 2013, Basic Definitions & Information, para. 4)

Complete continuing medical education registration policies and certifying examination eligibility requirements are available on the NCCAA website (NCCAA, 2009, homepage, CME, Examinations).

The Emory AA Program and BAHS 500

The EUAAP is a graduate level allied health science program that confers upon competent candidates the degree of Master of Medical Science in Anesthesiology. Approximately 40 students matriculate each June, and for the purposes of this study, are referred to as a cohort by the year they matriculated and enrolled in BAHS 500. Matriculants must have completed standard premedicine prerequisite courses (see Table

1) with a minimum grade of C (Emory University School of Medicine Master of Medical Science in Anesthesiology Program [EUAAP], 2013).

Table 1

Prerequisite Courses for Matriculation into EUAAP 2013

Course Title	Lab Required	No. of Semesters
English	No	1
Calculus	No	1
Biochemistry	No	1
General Biology	Yes	2
General Chemistry	Yes	2
Organic Chemistry	Yes	1
General Physics	Yes	2

Note: Adapted from Emory University School of Medicine Master of Medical Science in Anesthesiology Program. (2013). Prerequisites.

The EUAAP curriculum (see Table 2) consists of 27 consecutive months of didactic coursework, experiential simulation activities, and clinical rotations (EUAAP, 2013).

Table 2

Coursework in EUAAP Curriculum 2013

Semester	Course Title
1 Summer	Introduction to Clinical Anesthesia
	Anesthesia Delivery Systems and Equipment
	Physics for Anesthesia Practice
	Instrumentation/Physiology/Pharmacology/Simulation Lab
2 Fall	Human Anatomy & Cadaver Laboratory for AAs
	Human Physiology for AAs
	Clinical Methods
	Anesthesiology Practice
	Clinical Concepts & Correlations
	Physics for Anesthesia Practice
	Instrumentation/Physiology/Pharmacology/Simulation Lab
	Clinical Anesthesia
3 Spring	Clinical Methods
	General Pharmacology for AAs
	Pharmacology for Anesthesia Practice
	Principles of Instrumentation and Monitoring
	Principles of Airway Management
	Anesthesiology Practice
	Clinical Concepts & Correlations
	Instrumentation/Physiology/Pharmacology/Simulation Lab
	Clinical Anesthesia
4 Summer	Pharmacology for Anesthesia Practice
	Principles of Instrumentation and Monitoring
	Principles of Airway Management
	Anesthesiology Practice
	Clinical Concepts & Correlations
	Clinical Anesthesia
5 Fall, 6 Spring, & 7 Summer	Senior Seminar in Anesthesia
	Clinical Anesthesia

Note: Adapted from Emory University School of Medicine Master of Medical Science in Anesthesiology Program. (2013). Coursework.

BAHS 500 Human Anatomy with Cadaver Laboratory, the scientific study of the structure of the human body, is taught in the first fall semester over 15 weeks, and is divided into 4 lecture hours plus 10 cadaver laboratory hours per week (see Appendix A). BAHS 500 course objectives are to provide students with TLM and instructional methods such that they may: (a) construct a broad, solid, knowledge base of human anatomy upon which to build further scientific medical knowledge in subsequent EUAAP coursework; (b) develop schema for critical thinking and clinical decision-making; (c) transfer and apply that knowledge to the clinical practice of anesthesia resulting in safe and effective patient care; and (d) develop schema for lifelong learning (Pettus & Mitchell, 2013).

Statement of the Problem

As the EUAAP course director for human anatomy, my Problem of Practice (POP) involves transitioning this graduate level human anatomy course from a dissection to prosection course, and subsequently into a cadaver-less course with incorporation of clinical correlations, digital media, and instructional design of online teaching and learning (OTL). The time frame is two years. Why, what, and how other medical schools have done to facilitate these transitions will inform the curriculum redesign.

Disciplinary Approaches: Historical and Economic Lenses

Deeply understanding the POP commences with reviewing the literature on the history of human dissection, associated economic issues, current TLM, and current instructional methods of human anatomy courses. Specifically, the historical lens will inform on anatomic dissection as the basis for medical education, the recent incorporation of adjunct learning materials and technology in curricula, and the anatomy departments that have eliminated cadavers. Concordantly, the economic lens will inform on the associated costs of a cadaver laboratory, supply of cadavers, faculty reimbursement, supply of qualified faculty, demands by students (i.e., enrollment), and demands from students (i.e., customer service). TLM and pedagogy will be examined from the perspectives of various learning theories.

Dissection: From Clandestine Curiosity to Regulated Enterprise

The historical perspective explains why cadaver dissection occupies a central role in medical science (Perry & Kuehn, 2006). Hippocrates (c. 460 BC – c. 370 BC), the Father of Medicine who is also regarded as a founder of the science of anatomy, stated: "Anatomy is the foundation of medicine, and should be based on the form of the human body." (Persaud, 1984, p. 33) For hundreds of years, society in general and religious doctrine specifically, considered the posthumous desecration of the human body via dissection as blasphemous (Perry & Kuehn, 2006). This resulted in minimal medical advances between Hippocrates and the onset of the Renaissance artists come anatomists Leonardo da Vinci and Andreas Vesalius in the 15th century (Perry & Kuehn, 2006).

The Age of Enlightenment sparked a renewed interest in the human body. The rapid spread across cultures was facilitated by the invention of the printing press, which allowed Vesalius to publish the first anatomy textbook in 1543 (Mitchell et al., 2011). This led to a chain reaction of increased education of physicians, increased demand for cadavers, and increased work for suppliers of cadavers, known as resurectionists, who stole bodies from graveyards and sold them to anatomists (Mitchell et al., 2011; Perry & Kuehn, 2006). Other avenues for procurement were from public executions, hospitals, and poor houses, all of which sold the cadaver to the highest bidder (Mitchell et al., 2011; Perry & Kuehn, 2006). In 1831 in the U.S. and 1832 in England, dissection was legalized and regulated by the Anatomy Acts (Mitchell et al., 2011; Perry & Kuehn, 2006). Thus, resurectionist middlemen and body snatching were eliminated, and a formal donation process was established through the Anatomical Gift Association (Perry & Kuehn, 2006).

Economics of Available Bodies: Cadavers, Faculty, and Students

Today, the Anatomical Gift Association and similar organizations provide hundreds of cadavers to U.S. medical schools, the cost of which is passed along to students as part of their tuition and laboratory fees (Older, 2004; Perry & Kuehn, 2006). As shown in Table 3, the total cadaver lab cost paid to EUSOM by EUAAP in 2013 was $18,200 (M. A. Gregory, personal communication, July 30, 2013). Additionally, EUAAP pays EUSOM an annual overhead of 2.5% of students' tuition toward basic science faculty salaries (R. Brouillard, personal communication, July, 23, 2013). Expenses associated with the cadaver laboratory and faculty reimbursement, combined with decreasing time available to students to spend in lab actively dissecting secondary to inclusion of new courses (mostly on medical technology and new medical techniques) in the curriculum, are reasons frequently given for contributing to the medical education paradigm shift (Carleton, 2012; Korf et al., 2008; Older, 2004).

Table 3

EUAAP Cadaver Laboratory Fees 2013

Item	Cost	Occurrence	Total
Cadavers	2200	4 bodies	8800
Cadaver set up	75	4 bodies	300
Use of lab space	150	12 weeks	1800
Waste disposal	150	12 weeks	1800
Examination gloves	1000	Annual	1000
Dissection instruments	3000	Annual	3000
Laboratory coats	1500	Annual	1500
Annual Total			18,200

Note. Adapted from M. A. Gregory, personal communication, July 30, 2013; S. A. Mitchell, purchase orders, August 2013.

From an economics perspective, many anatomy departments are facing a decrease of qualified faculty with a simultaneous increase in student enrollment (Korf et al., 2008). Compounding the issue further, is the trend of decreasing allotment of course hours available to teach anatomy with a concomitant increase in the amount of new clinical content added to the anatomy course specifically and the school-wide curriculum in general (Baker, Slott, Terracio, & Cunningham, 2013; Rizzolo, Rando, O'Brien, Garino, & Stewart, 2011; Rizzolo et al., 2010). Recommendations set by the AMA and ACGME for clinical integration of basic science content creates a deficit in qualified faculty (Baker et al., 2013; Carraccio, Wolfsthal, Englander, Ferentz, & Martin, 2002; Machado, Barbosa, & Ferreira, 2013; Rizzolo et al., 2011; Rizzolo et al., 2010). Basic science courses (e.g. anatomy, physiology, pharmacology) are typically taught by PhDs with little or no clinical experience. To fill the gap, clinicians must be brought on board to effectively teach clinical relevance and skills. However, this results in an added expense on two levels: (a) reimbursement of additional personnel per instructional hour; and (b) clinical faculty are compensated at a higher rate than basic science faculty (R. Brouillard, personal communication, March 13, 2014).

EUSOM provides a sufficient number of qualified basic science faculty to meet student enrollment, however, they lack the clinical experience necessary to meet all the learning demands of the students. As an AA with human anatomy cadaver lab teaching experience, I fill the niche nicely. My faculty appointment in the EUAAP involves additional courses and committee appointments, such that the anatomy reimbursement is extended across my other faculty commitments, and it is justified by my ability to integrate clinical relevance to anatomy topics thereby enhancing the students' learning experience (R. Brouillard, personal communication, March 13, 2014).

Conversely, there are economic benefits of the proposed changes to BAHS 500. If the time I spend teaching anatomy decreases, then I will be available to do other EUAAP work, which will economically benefit EUAAP. If the time students spend learning anatomy in the classroom and laboratory decreases, then they will be available to do other coursework, attend clinical rotations, and practice self-reflection. Also of consideration, is time spent commuting between EUAAP office building and EUSOM cadaver laboratory, which averages 45 minutes each direction. An additional block of three hours per week would benefit faculty, students, and EUAAP. Notwithstanding the theme of *time is money*, curriculum revision must maintain a level of graduate coursework commensurate with an MMSc degree and contain depth of knowledge appropriate for AAs. The revised curriculum must also be grounded in pedagogy that affords students opportunities to learn.

Theoretical Framework: How People Learn Anatomy

Various perspectives and theories assist in understanding how learning occurs. Models provide schema for applying these theories to teaching. The foundational principles of the constructivist perspective are summarized as: (a) humans are active learners; (b) individuals must construct, or assimilate, knowledge for themselves; and (c) construction of knowledge occurs through social interactions and private speech (Bruning, Schraw, & Norby, 2011; Schunk, 2008). Concordantly, the cognitive psychology perspective focuses on human perception, thought, and memory. Bruning et al. (2011) describe learning as an active/applied process via 8 cognitive themes: schema, processing, constructive memory, practice, motivation, self-actualization (metacognition), conditionalization, and social interaction. Bransford, Brown, and Cockings (2000) also list schema and metacognition, and additionally describe the importance of acknowledging students' preconceptions regarding the subject matter.

These perspectives on teaching and learning have roots in the works of Piaget and Vygotsky. Trained as a biologist, Piaget (1952) studied how children utilized experiential learning to actively engage with their environment, adapt, and assimilate knowledge into memory. Vygotsky (1962; Rieber & Carton, 1987) contended that humans have an adaptive capacity to alter their environment, and use social interactions to "stimulate developmental processes and foster cognitive growth" (Schunk, 2008, p. 243).

Teaching and Learning Methods

The constructivist perspective has several implications for teaching methods and curricula design. If the goal of education is to produce independent thinkers with mastery of the material, that is, to generate understanding rather than merely aiming at the repetition of behaviors, then teaching methods should reflect and cultivate these outcomes (Schunk, 2008; Von Glaserfeld, 1988). The teaching and learning of anatomy as a basic science can be exhaustive yet shallow. Learning anatomical terms, identifying structures, and locating structures within the human body can be done with glib information processing by students. However, learning anatomy to practice medicine is like learning the alphabet to write a composition paper: the knowledge base must be (a) profound and concrete; (b) centered around clinically relevant schema; (c) transferable to the clinical environment; and (d) optimized for conditionalization in the clinical environment (Barrows, 1986; Chan, 2010; Drake, 2007; Ogard, 2014). As Ertmer and Newby (2013) asked, “How should instruction be structured?” (p. 66)

Vygotsky’s (1962; Rieber & Carton, 1987) social constructivist theory emphasizes group learning and peer collaboration. This is in alignment with the current concept of student-centered learning, where the instructor does not teach in the traditional sense of lecturing to a group of students, but rather acts as a facilitator and guider of learning processes (Schunk, 2008). In this approach, language is used by the instructor to guide the student’s construction process, but does not transfer knowledge directly to the student (Von Glaserfeld, 1988, 2005). The instructor acting as a facilitator is a long recognized goal of medical education that has historically been part of the hidden curriculum, and it is now increasingly being used in the ‘obvious’ curriculum through the model of reciprocal peer teaching (Krych et al., 2005). Reciprocal peer teaching (RPT), also referred to as *peer learning* by Boud, Cohen, and Sampson (2001), is a contemporary application of Vygotsky’s (1962; Rieber & Carton, 1987) social constructivist theory (Bransford et al., 2000; McLeod, 2010; Schunk, 2008). The experiences of teaching others and working with others to present material are valuable skills for clinicians to develop, especially because the model of medical education is largely still that of apprenticeship (Krych et al., 2005). Furthermore, RPT prepares students for teaching roles as clinical preceptors in their professional practice, and increases their teaching and communication skills with colleagues and patients (Krych et al., 2005).

Additional teaching methods include scaffolding, modeling, creating schemata, and verbalization of inner thoughts (Schunk, 2008). Vygotsky's (1962; Rieber & Carton, 1987) *zone of proximal development* (ZPD) describes the developmental potential of an individual as measured from his current independent problem solving toward his higher level of mental functions with the guidance of an adult/expert (Bransford et al., 2000). By using these teaching methods within each student's ZPD, instructors can assist students with creating meaning from their applied learning experiences (Ertmer & Newby, 2013). Some examples of applied learning exercises utilized in medical education include problem based learning discussions, self-reflection, clinical skills simulation, case studies, and clinical decision-making (McLaughlin et al., 2014; Rizzolo et al., 2011; Rizzolo et al., 2010).

Through development and incorporation of case studies and problem-based learning discussions, a schema of clinical anatomy anesthesia correlations will be created and serve as a means for conditionalized transfer of anatomy knowledge to clinical practice. Bruner's (1966) Concept of Transfer theory surmises that the goal of education is to create autonomous learners (Bransford et al., 2000; McLeod, 2008). Along the lines of Bruner (1966) the ultimate goal is to produce independently thinking, competent clinicians. With the schema of correlations, the students can learn to develop critical thinking skills like deductive reasoning and differential diagnosis.

Notwithstanding the positive applications of the cognitive and constructive perspectives to the project, there are also weaknesses of this theoretical approach. Because anatomy is taught in the second semester (out of seven), students have only minimal clinical knowledge. Lack of clinical experience is a weakness to this correlation approach because students are unable to make cognitive links between anatomy and anesthesia practice. A profound knowledge base of anatomy is all but useless without the ability to apply it correctly to clinical situations. As such, basic clinical concepts and skills must be co-taught with anatomy to enable a deep level of critical thinking. The use of correlations as a schema for transference of knowledge from the classroom to the clinic would be more effective if students have an adequate prior knowledge base of the clinical practice of medicine.

Secondarily, there are issues that these perspectives may not be suited to address. For instance, how and when can transference and conditionalization be assessed? Ideally, assessment would occur during the clinical phase (semesters five through eight) of education, not the didactic phase (semesters one through four). However, that is impractical for reporting of semester-end grades for this traditional 15-week course taught in the second semester. Addition of the behaviorist approach could utilize simulated objective structured clinical exams (OSCEs), but that assessment technique and authentic activities are already covered in the concomitantly taught course ANES 505 Human Patient Simulation (HPS) Laboratory (EUAAP, 2013). To include such assessments in ANES 525 would be duplicitous.

Also with respect to time, another curriculum change would be necessitated if metacognition were to remain as a goal of the anatomy course. According to Bruning et al. (2011), the curriculum should be self-paced to allow students' time for comprehension, integration, transference, and conditionalization of information. This is in opposition to the EUAAP curriculum that is time-based because topics across courses are tightly aligned. For instance, cardiac anatomy must precede cardiac physiology, which must precede HPS lab. Medical education is moving in this direction, albeit slowly, as faculty resources (e.g., teaching days versus clinical days) and classroom block times (e.g., access to cadaver and HPS labs) pose logistic barriers to managing multiple cohorts of students working on incongruent assignments (R. Brouillard, personal communication, March 13, 2014; E. Pettus, personal communication, March 19, 2014; Krych et al., 2005). Potentially, flipping the classroom could afford instructors the ability to dedicate in-class time to student-centered learning (McLaughlin et al., 2014). As a result of shifting traditional lecture time to prerecorded presentations available online and out of class, students would then be afforded opportunities for metacognition and reflection (McLaughlin et al., 2014).

Metacognitive Skills

As stated on the EUAAP website, "The [Anesthesiologist Assistant] program accepts qualified individuals who desire to undertake rigorous didactic and clinical education in order to become knowledgeable, skilled anesthetists" (EUAAP, 2013). *Skilled anesthetists* are those individuals who graduate with a beginner level of clinical performance, and advance along a continuum toward expert status in the Bransford et al.

(2000) model for achieving expert knowledge status. An integral component of this process involves Flavell's (1979) model of cognitive monitoring:

> My present guess is that metacognitive experiences are especially likely to occur in situations that stimulate a lot of careful, highly conscious thinking; in a job or school task that expressly demands that kind of thinking; in novel roles or situations, where every major step you take requires planning beforehand and evaluating afterwards; where decisions and actions are at once weighty and risky; where high affective arousal or other inhibitors of reflective thinking are absent. (p. 908)

In my opinion, he has perfectly described the job of an anesthetist who is providing anesthesia to patients undergoing surgical procedures in the operating room. He prompts me to ponder by what theories/models/methods can anesthesia students be instructed and assessed in cognitive monitoring, and is it feasible to integrate into the anatomy course? However, that is an entirely separate, yet highly important, problem of practice. The anatomy curriculum must first be redesigned on a basic functional level prior to progressing to the level of cognitive monitoring.

Teaching and Learning Materials

A multitude of constructivism perspectives have been described (Bransford et al., 2000; Bruning et al., 2011; Ertmer & Newby, 2013; Schunk, 2008; Von Glaserfeld, 1988, 2005). Amarin and Ghishan (2013) summarize the general characteristics:

- People of all ages do not discover knowledge; rather they construct or make it.
- People create knowledge by relating or connecting it to their previous knowledge.

- Learning involves applied cognitive activity and cognitive restructuring.
- People use personal experiences to create knowledge.
- Cognitive growth is stimulated when people are confronted with practical or personal problems that create cognitive disconnects. (p. 54)

In the learner-centered environment, ways in which students acquire and store knowledge in memory is paramount to their learning success. Not only is this success dependent upon the methods, but also the materials. Teaching and learning anatomy involves the use of language, images, and manipulatives. Rather completely, Bruner's (1966) information processing model applies to the subject of anatomy via his three modes of representation: symbolic, iconic, and enactive. Medical terminology is the symbolic representation through which clinicians communicate. By reading the textbook, listening to lecturers, and conversing in class, students become adept at reading, writing, and speaking this new language. Textbooks and digital media contain innumerous iconic illustrations, histologic and cadaveric photographs, and actual medical images, such as Computed Tomography (CT) and Magnetic Resonance Imaging (MRI). Dissecting cadavers, examining plastinated specimens, and assembling/disassembling plastic models are enactive motor tasks that utilize manipulatives.

To begin the process of redesigning the course, careful consideration of the literature in best practices must be examined. This literature review next investigates why, how, and what other medical education programs have done in the redesigning of anatomy curricula, with specific attention to: (a) educational perspectives on teaching and learning that support or contest the transition away from cadavers; (b) availability, affordability, and effectiveness of teaching and learning materials; (c) availability, feasibility, and effectiveness of teaching and learning methods; (d) ability of students to achieve course learning objectives; (e) faculty and student perceptions of TLM and methods. Concepts, constructs, and literature research questions guiding the literature review are presented.

1. Concept: If the enactive mode of dissection and the manipulative of cadaver specimens are eliminated, what alternative TLM may provide similar, sufficient means for students to construct knowledge?

    Construct: Using Bruner's information processing model of three modes of representation based on cognitive theory, the materials can be categorized as enactive, iconic, or symbolic.

    LRQ1: What TLM have been shown to affect positive learning outcomes?

2. Concept: If the activity of cadaver dissection is eliminated, what remaining instructional methods may provide similar, sufficient means for students to actively construct knowledge?

    Construct: Using social constructivist theory, the instructional methods can be categorized as teacher-centered teaching, student-centered learning, facilitating, scaffolding, modeling, creating schemata, and verbalization of inner thoughts.

    LRQ2: What teaching and learning methods have been shown to affect positive learning outcomes?

3. Concept: Students' attitudes, motivation, beliefs affect their engagement, learning, and performance (Bransford et al., 2000; McLaughlin et al., 2014).

Construct: Because students are stakeholders and participants, their perceptions of TLM and instructional methods are informative from an educational psychology metacognitive/affective theory perspective.

LRQ3: What are students' perceptions of various TLM?

LRQ4: What are students' perceptions of various instructional methods?

Literature Review: Paradigm Shift in Materials and Methods

The teaching and learning of human anatomy in medical education is undergoing a paradigm shift in TLM, pedagogic instruction methods, and assessment methods utilized in the classroom, laboratory, and clinic (Brenton et al., 2007; Fruhstorfer, Palmer, Brydges, & Abrahams, 2011; Korf et al., 2008; Tworek, Jamniczky, Jacob, Hallgrimsson, & Wright, 2013). The TLM shift is from the long-standing tradition of cadaveric dissection toward a multimedia approach that includes: (a) prosection; (b) plastinated specimens; (c) plastic models; (d) living anatomy (students examine each other); (e) medical images (e.g. radiology and ultrasonography); (f) virtual microscopy (histology via digital images has replaced microscope use); and a newly available repertoire of (g) 2D digital images; (h) 3D computerized models; and (i) virtual cadavers (Brenton et al., 2007; Carleton, 2012; Fruhstorfer et al., 2011; Korf et al., 2008; Older, 2004; Tworek et al., 2013). Information technology has thoroughly infiltrated the delivery of education and medicine, and anatomy curriculum designers and instructors are contending with its integration into their field. For the benefit of the students, medical education continuously seeks to include advances in OTL and medical technology in both didactic and clinical learning environments.

Simultaneously, the culture and pedagogy of academic medicine are shifting from traditional lecture hall dissemination of information toward problem based learning (PBL), authentic activities, RPT, computer aided learning (CAL), projects, and self-reflection (Husmann, O'Loughlin, & Braun, 2009; McLaughlin et al., 2014; Pawlina & Drake, 2013). Fortuitously, the flipped classroom instructional method enables faculty time to be reallocated from teacher-centered lectures to student-centered learning activities (McLaughlin et al., 2014; Pawlina & Drake, 2013). In this blended course model, instructional methods are in alignment with medical education pedagogy shifting from segregated didactic and clinical learning blocks to a curriculum that integrates basic science learning (i.e., practical laboratory, experiential learning, human patient simulation, problem based learning, small group discussions, lectures, online teaching and learning) with clinical rotations (i.e., legitimate peripheral participation, authentic learning environments, direct patient care, apprenticeship) (McLachlan, Bligh, Bradley, & Searle, 2004; McLaughlin et al., 2014; Sugand, Abrahams, & Khurana, 2010). To optimally understand the forward direction of this shift, the historical lens returns to cadaver dissection to inform the past and present states of anatomy instruction.

Perceived Benefits of Dissection

Human anatomy is the scientific study of the structure of the human body. It is divided into gross anatomy, histology, embryology, and neuroanatomy. Historically, dissection of cadavers has been the cornerstone of anatomy instruction (Brenton et al., 2007; Older, 2004; Perry & Kuehn, 2006). Brenton et al. (2007) list popular beliefs as to the benefits that cadaveric dissection provides medical students:

- Learning the basic language of medicine needed to describe the structure (anatomy) and function (physiology) of the human body.
- Establishing the primacy of the patient as a person as opposed to a series of diagrams or photos in a textbook.
- Acclimatising [*sic*] students to the realities of death.
- Teaching manual dexterity and touch-mediated perception.
- Introducing the concept of anatomical variation (there are significant internal differences between humans).
- Gaining knowledge of the three-dimensional spatial relationship between structures.
- Gaining communication skills within a small peer group. (p. 33)

Reflecting on the perceived benefits that dissection affords medical students in regard to the POP, I am foremost concerned with ensuring that AA students are provided TLM and IM necessary to develop three-dimensional spatial relationship between structures. The remaining six benefits are replicated via other means in BAHS 500, and/or they are covered in other parts of the EUAAP curriculum.

Cadaveric Dissection versus Prosection

Reasons oft given for this transition away from dissection as the primary TLM and method of anatomy instruction are high costs of cadaver laboratory maintenance and faculty reimbursement, compounded with dwindling time available for students to spend dissecting (Carleton, 2012; Korf et al., 2008; Older, 2004). Cuddy, Swanson, Drake, and Pawlina (2013) investigated the effects of variation in: (a) anatomy course hours (i.e., time spent in lab was significantly greater for dissection versus prosection); (b) curriculum type (e.g., traditional regional-based vs. system-based); and (c) laboratory experience (e.g., cadaver dissection versus prosection with minimal dissection) on student achievement. The purpose of the study was to provide empirical evidence about the relationships between anatomy instruction and its impact on the acquisition and retention of anatomy knowledge as measured by medical students' academic achievement scores on United States Medical Licensing Examination (USMLE) Steps 1 and 2 (Cuddy et al., 2013). An online survey of medical school program directors and anatomy course directors was matched with students' USMLE scores, and Cuddy et al. (2013) concluded the instructional strategies examined were unrelated to USMLE performance. This study informs that medical students can develop a knowledge base and successfully transfer the knowledge to standardized examinations that require clinical reasoning skills despite differences in instructional strategies. The authors cite several studies corroborating these results (Cuddy et al., 2013).

These study results increase my confidence in proceeding with the transition to fewer lab hours for AA students, the elimination of dissection, and the use of prosected cadavers in redesigning the curriculum. Yet, the course redesign is slated to eliminate cadavers entirely. In addition to cadaveric specimens, EUAAP and EUSOM have plastic models and plaster models as available TLM. Although I regard these manipulatives as 'better than nothing', they are not a substitute for, nor comparable to, human tissue in terms of detail, texture, size, and authenticity. To further inform on available, feasible, and effective TLMs, a review of plastinated specimens as a replacement for cadavers is next.

Manipulatives: Cadaveric Specimens versus Plastinated Specimens

Many techniques for preservation of cadaveric specimens have been used over the centuries: salt, oils, balsams, resins, dehydration, wax injection, dyes, mercury, spirits (alcohol, wine, turpentine), lacquer/varnish, and glycerin (Mitchell et al., 2011). Formalin, phenol, and other proprietary liquid solutions are currently used to embalm cadaveric specimens (Mitchell et al., 2011). These specimens last in the range of several months to 10 years, depending upon the solution and the intended usage for each specimen (Mitchell et al., 2011). The most recent advancement is the technique of plastination, which was developed by Gunther von Hagens in 1977 (Von Hagens, 2006). Plastination is a method by which fresh tissue specimens are preserved. It involves a series of embalming and preservation steps where the water in cadaveric tissue is replaced by polymers, resulting in a permanent specimen that can be used by many students over many years (Von Hagens, 2006). As such, plastinated specimens can be manipulated in a similar manner as cadaveric specimens (Von Hagens, 2006).

Feasibility. Purchase of anatomic teaching materials from Von Hagens Institute for Plastination requires an initial investment of $50,000-90,000 per cadaver, and $5,000-35,000 for each additional custom organ/section (D. Seifert, personal communication, December 6, 2013). To eliminate fresh cadavers and replace them with plastinated specimens for fall 2014 is unlikely given that the budget has been finalized. Options to purchase plastinated specimens for fall 2015 are: (a) reallocate the budget; (b) secure a loan; (c) secure a grant; (d) negotiate a payment plan with the supplier; and (e) increase student laboratory fees. Given that the program directors gave instructions to eliminate cadavers, little if any justification for expenditures should be necessary, and the cost can be distributed across multiple cohorts due to the longevity of the plastinated specimens (R. Hall, personal communication, October 4, 2013).

Effectiveness. Would Bruner concede that enactive representation of knowledge through plastinated specimens is equal to cadaveric tissue? It is possible students' quality of learning (i.e., depth of knowledge, motivation for learning, acquisition of knowledge) could be diminished by utilizing human tissue infused with plastic instead of the customary preservative fluids.

Baker et al. (2013) studied the elimination of cadavers and the incorporation of von Hagens' plastinated specimens at New York University College of Dentistry. The study concluded faculty and students' satisfaction was increased, and students' test scores on the National Board of Dental Examination Part 1 increased after the curriculum revision (Baker et al., 2013). In a similar quantitative and qualitative study, Latorre et al. (2007) examined first-year medical and veterinary students' learning of anatomy. Students were divided into a control group that used wet cadaver prosected specimens and an experimental group that used plastinated specimens (Latorre et al., 2007). Methods used were pretests, posttests, and opinion surveys (Latorre et al., 2007). Results showed no differences between groups for pretest scores and posttest scores, and significant differences between intragroup pretest and posttest scores for both the control and the experimental groups (Latorre et al., 2007). The authors quantitatively confirmed the efficacy of plastinated specimens as TLM (Latorre et al., 2007). The surveys qualitatively informed the authors that both instructors and students considered plastinated specimens useful for teaching and learning anatomy (Latorre et al., 2007). Comparable studies by Fruhstorfer et al. (2011) and Moore, Lowe, Lawrence, and

Borchers (2011) showed evidence of similar results.

Because students demonstrated learning and reported satisfaction with plastinated specimens as TLM (Baker et al., 2013; Fruhstorfer et al., 2011; Latorre et al., 2007; Moore et al., 2011), I feel confident in proceeding with the transition to a cadaver-less lab that utilizes plastinated specimens. The aforementioned studies are best summed up in a statement by Baker et al. (2013): "Our conclusion, therefore, is *not* that replacing dissection with study of plastinated specimens *will* lead to positive results, but rather that the study of plastinated specimens *can* be a highly successful replacement for dissecting cadavers." (p. 1507)

Although the motor tasks of dissection and handling of cadaveric specimens are not considered a necessary clinical skill set of an AA, I acknowledge that enactive representation with human specimens, regardless of the preservation method, may be important to learning anatomy from a constructivist perspective. Should EUAAP administrators deem plastinated specimens too costly, the constructivist perspective informs the need to identify effective alternatives. Research on utilization of virtual cadavers, living anatomy, and CAL is examined next.

Digital Media: Cadavers versus Computers

Students have access to electronic textbooks, digital images, medical images, three-dimensional computer models, animations, videos, and inestimable websites. Electronic textbooks and software programs cost in the range of $60-$300, but a vast amount of digital media is open access. Many anatomy course directors have integrated digital media with success as measured by test scores and satisfaction surveys (Baker et al., 2013; Brenton et al., 2007; Codd & Choudhury, 2011; Husmann et al., 2009;

Ivanusic, Cowie, & Barrington, 2010; Kesner & Linzey, 2005; Machado et al., 2013; O'Byrne, Patry, & Carnegie, 2008; Perry & Kuehn, 2006; Rizzolo et al., 2011; Rizzolo et al., 2010; Salajan et al., 2009). In a study by Hallgren, Parkhurst, Monson, and Crewe (2002), students who used digital images and computer models to learn anatomical landmarks performed better in examinations than a control group who did not have access to the material but rather only cadavers. Adamczyk, Holzer, Putz, and Fischer (2009) reported similar results from an analogous study on first year medical students. Brenton et al. (2007) listed a benefit of three-dimensional computer models as “the ability to view spatial relationships between structures from numerous viewpoints” (p. 40). These models can be animated to demonstrate function, development, disease progression, and surgical techniques (Brenton et al., 2007). The emphases on embryology, physiology, pathophysiology, and surgery likely serve as motivators for learning by creating correlations between anatomy and clinical medicine (Rizzolo et al., 2010; Salajan et al., 2009). Three-dimensional computer models are considered superior to two-dimensional images for learning anatomy, because two-dimensional images do not show spatial relationships (Brenton et al., 2007; Salajan et al., 2009). However, the clinical diagnostic gold standard of two-dimensional medical images, like MRIs and CT scans, require expertise to interpret because the viewpoint is fixed and cannot be manipulated (Brenton et al., 2007). It is imperative that AA students develop the ability to visualize anatomic structures in three dimensions, thusly using Bruner’s (1966) iconic representation to acquire knowledge for future transfer to clinical applications.

Another advantage of virtual anatomy is the ability of computers to provide students with self-assessment exercises, or computer-assisted learning (CAL). From a cognitive perspective, approaches to learning emphasize metacognition, self-paced learning, and extended practice through repetition (Bransford et al., 2000; Bruning et al., 2011). Additionally, "self-assessment exercises and real time feedback are an important component because they help students assess their own knowledge and highlight areas that require further study" (Brenton et al., 2007, p. 41).

The Visible Human Project and medical imaging. Initiated by the United States National Library of Medicine in 1988, The Visible Human Project (VHP) provides a computerized database of transverse sections of the human body, complete with corresponding CTs and MRIs (Ackerman, Spitzer, Scherzinger, & Whitlock, 1995; Jastrow & Vollrath, 2003). The value of cross sectional anatomy training in medical education has been previously demonstrated (Ackerman et al., 1995; De Barros, Rodrigues, Rodrigues Jr, De Negri Germano, & Cerri, 2001; Tavares, Dinis-Machado, & Silva, 2000). As a student in the School of Medicine's Medical Sciences program at Indiana University Bloomington in 1995, I studied cross sectional anatomy using one inch thick cadaveric slices preserved in glass cylinders of liquid formalin, plastinated brain sections, and CT films via light boxes. Unfortunately, these three mediums were from three different humans, so there was not correlation among structures.

With the ubiquitous use of computers in daily life, university courses, and medical practice, comes the availability of technologies such as the VHP, CT, and MRI. Because these imaging tools are the diagnostic gold standards of clinical practice, I concur with the academic medical community that anatomy curricula must facilitate the development of students' abilities to read medical images (Jastrow & Vollrath, 2003; Machado et al., 2013; Rizzolo et al., 2010; Shaffer, 2004). Multiple studies demonstrate this learning goal can be accomplished by correlating anatomical structures of the human body with medical images as part of a medical anatomy course (Jastrow & Vollrath, 2003; Machado et al., 2013; Rizzolo et al., 2011; Rizzolo et al., 2010; Shaffer, 2004).

Within BAHS 500, I currently utilize some correlated cross sectional, MRI, and CT digital images. In subsequent years, I plan to incorporate the VHP media into the course to further enhance students' learning of anatomy and their transfer of knowledge to clinical practice. This would enhance the iconic representation area of the curriculum, and is an opportunity to incorporate pathology, diagnostic medical imaging, and clinical reasoning skills.

In addition to constructivism, the cognitive perspective on teaching and learning presented by Bruning et al. (2011) applies to cross sectional anatomy. Students develop schemata to guide thought, organize memory, and facilitate recall through correlating cross sectional cadaveric images with computerized medical images (Bruning et al., 2011; Machado et al., 2013; Rizzolo et al., 2011; Rizzolo et al., 2010). This is a cognitive process of *learning with understanding* that encourages conditionalization of knowledge, and which can be cultivated through extended practice via self-directed learning because students have continuous computer access (Bruning et al., 2011; Codd & Choudhury, 2011; Husmann et al., 2009; Kesner & Linzey, 2005; O'Byrne et al., 2008; Rizzolo et al., 2011; Rizzolo et al., 2010). Additionally, by using the conceptual framework of medical images on which clinicians base diagnoses and patient care decisions, students' motivation to learn and their ability to transfer knowledge to clinical practice may both be increased (Bransford et al., 2000; Machado et al., 2013; Rizzolo et al., 2011; Rizzolo et al., 2010).

The LINDSAY Presenter Virtual Human Project. The LINDSAY Presenter Virtual Human Project is software for three-dimensional anatomy teaching using two-dimensional computer interfaces, and is the product of collaboration among several Canadian universities (Tworek et al., 2013). The researchers performed a three-week pilot study to investigate the use of the LINDSAY Presenter by medical students at the University of Calgary (Tworek et al., 2013). A qualitative case study collected data via observation, field notes, and focus groups; quantitative data was collected via pre/post surveys (Tworek et al., 2013). The researchers concluded the LINDSAY Presenter software was a detractor from learning, due to the steep learning curve and labor-intensive nature of using the software that required students to focus more on learning the software than on learning anatomy. This finding is parallel to reports in digital education literature, which cite learning to use the technology can be a detractor or barrier to learning the subject matter (Shaffer, 2004; Tworek et al., 2013).

This study informs the importance of selecting user-friendly virtual anatomy software. The enactive representation of learning the software must not supersede nor interfere with the enactive representation of learning the anatomy subject matter (Shaffer, 2004; Tworek et al., 2013). Perhaps the same argument could be made for full cadaver dissection because learning how and what to cut out versus what to keep is a steep learning curve as well.

Virtual microscopy. Similar to learning to dissect, learning to operate a conventional light microscope is a skill that takes practice. Husmann et al. (2009) developed Virtual Scope, a digital media virtual microscopy application, and made it accessible to students through their anatomy course website. Quantitative results of student performance showed increased exam scores, decreased withdrawal rates, and an increase in number of students earning a C or better, as compared to the previous year's cohort that used conventional light microscopes (Husmann et al., 2009). The researchers discussed the advantages Virtual Scope afforded to students, including availability of material outside of the lab, less of a learning curve to develop virtual microscopy skills (i.e. ease of use of the software application), and increased collaboration among students due to screen sharing (Husmann et al., 2009). Qualitative results from a student survey corroborated that ease of use and availability were highly valued attributes of the application (Husmann et al., 2009).

The EUAAP anatomy course reincorporated minimal histology in 2013; it had been eliminated from the course by EUSOM basic science faculty in 2010. The main barriers were lack of access to microscopes and slides and lack of knowledge about available virtual microscopy applications.

Conclusion

With the advancement of technology and the extensive availability and use of computers, the necessity for the long-standing traditional dissection of human cadavers has been challenged in recent years (Brenton et al., 2007; Cuddy et al., 2013; Drake, McBride, Lachman, & Pawlina, 2009; Fruhstorfer et al., 2011; Korf et al., 2008; Latorre et al., 2007; McLachlan et al., 2004; Older, 2004; Sugand et al., 2010; Tworek et al., 2013). There are valid pedagogical reasons for the continued use of dissection, despite logistic, economic, and psychological difficulties (Brenton et al., 2007; Older, 2004; Shaffer, 2004; Sugand et al., 2010). Contrastingly, there is research validating pedagogical changes to anatomy curricula where dissection is replaced by virtual anatomy with computerized media, plastinated specimens, and medical images (Cuddy et al., 2013; Fruhstorfer et al., 2011; Korf et al., 2008; Latorre et al., 2007; McLachlan et al., 2004). Anatomy curriculum designers and instructors must thoroughly vet and validate the inclusion and substitution of technology as TLM, and must concordantly align instructional methods.

This literature review has informed on the history of anatomic dissection practices, current methodologies and learning materials available to anatomy instructors and students, and the economic variables associated with dissection, specimens, and technology. Ultimately, the goal is to provide AA students with methods, materials, opportunities, and support to facilitate learning. I identify with a recommendation from Shaffer (2004): “Whatever the future holds, it is important not to change simply because change is possible. We must understand the virtues of these teaching methods in order to make the best use of them — and to select the most appropriate new methods to supplement or replace them.” (p. 1281) The needs assessment is detailed in the next chapter. Goals and objectives, methods, results, discussion, conclusion, and further considerations will be reported.

Chapter 3: Needs Assessment

Needs Assessment of Course Design, Pedagogies, and Teaching and Learning Materials Utilized for BAHS 500 Human Anatomy with Cadaver Laboratory

Needs Assessment Purpose

Advancements in medical imaging, virtual cadaver software, and digital learning media suggest that a blended course for human anatomy may be possible with elimination of cadavers and f2f lectures, and inclusion of digital media and authentic activities. This needs assessment documents the current design and status quo of the EUAAP human anatomy course, BAHS 500. The focus is on gathering and analyzing data, and constructing knowledge to inform decisions on changes that could and should be made to the course. An additional cognizant effort is made to identify and describe gaps that may need to be filled through further research.

Goals and Objectives

As EUAAP course director for BAHS 500 Human Anatomy with Cadaver Laboratory, my goal is to redesign the course per the program directors' specifications: (a) transition from a dissection to prosection course, and subsequently into a cadaver-less course; (b) incorporate new TLM, clinical correlations, digital media, and OTL; (c) incorporate progressive medical education pedagogy; and (d) align the course with the overall curriculum. The new course will be entitled ANES 525 Applied Anatomy for Anesthesia Practice. Thus, the primary objective is to assess the BAHS 500 with regard to TLM, instructional methods, stakeholders' perceptions (e.g., students and faculty) of the materials and methods, and available (but not currently utilized) resources. A secondary objective is to compare and contrast Emory's current and available resources to what the literature review revealed is evidence-based best practice. This will inform future decision-making pathways and instructional design of ANES 525. An overview of inputs, participants, outputs, and expected outcomes is depicted in the logic model (see Figure 1).

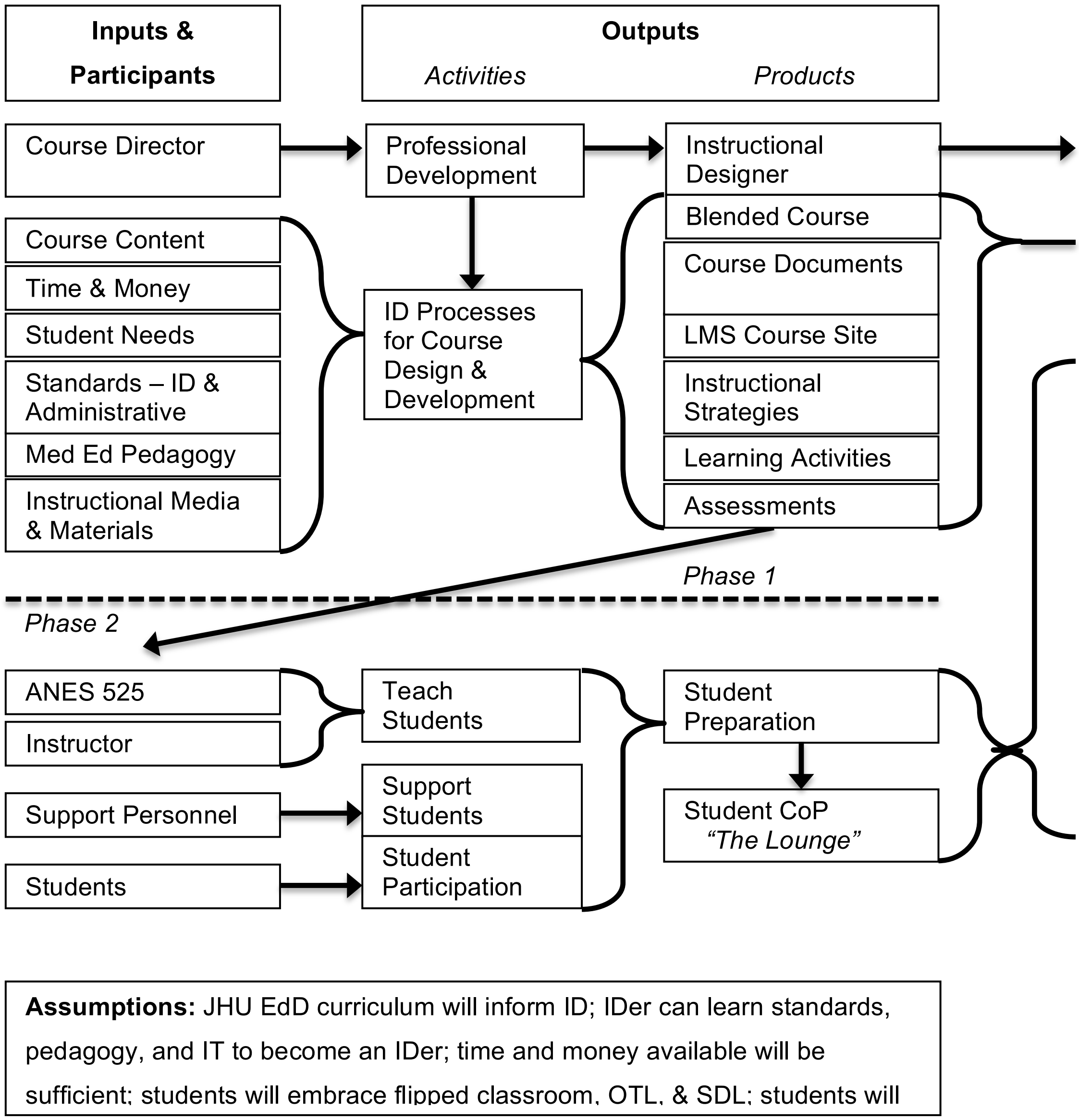
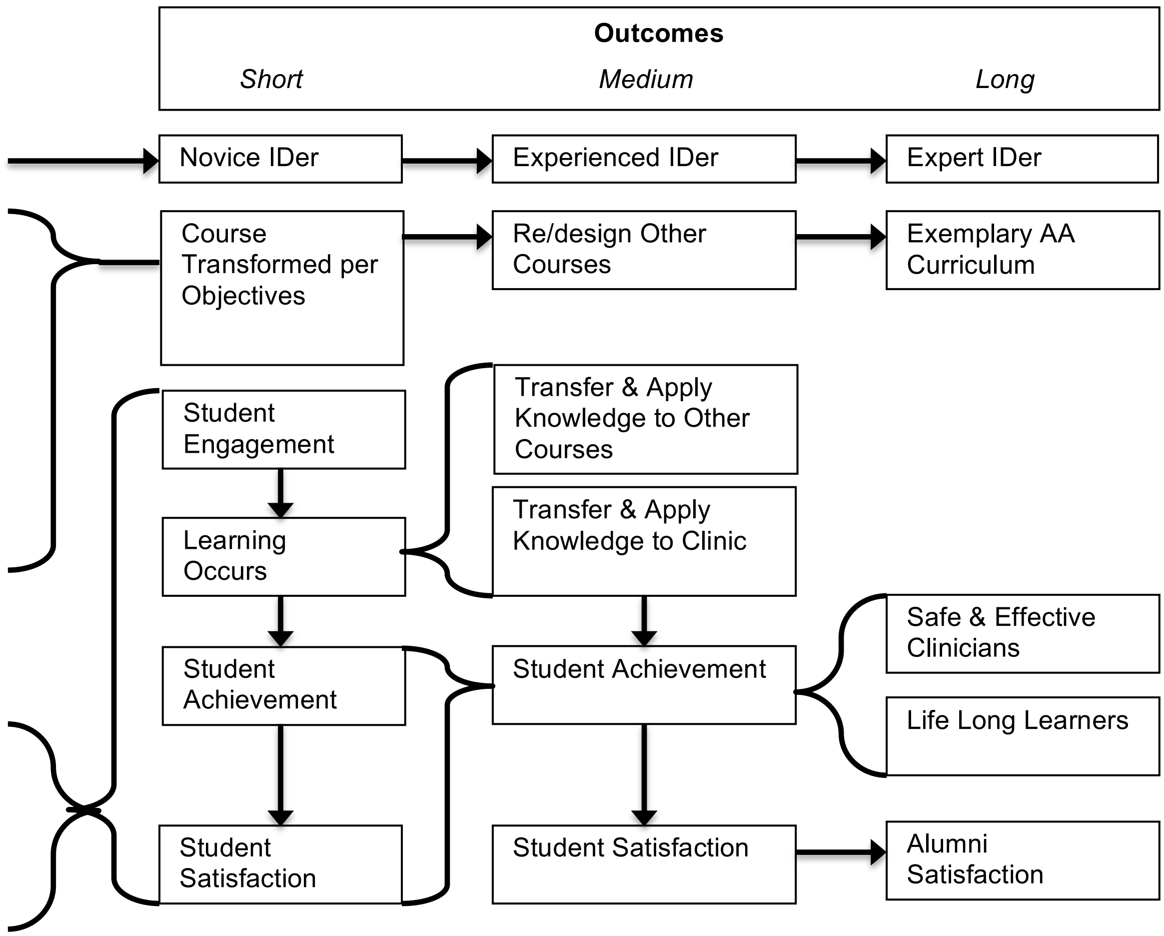


Figure 1. Logic model for ANES 525 Applied Anatomy for Anesthesia Practice. Reduction in course credit hours and elimination of cadaver laboratory necessitates transformation of BAHS 500 to ANES 525. The objectives are to align pedagogy with medical education practices and IDOTL, incorporate digital media, and demonstrate clinical relevance of anatomy to anesthesia practice in order to achieve the goal of educating anesthesiology assistant students.

(Figure 1 cont.)



External Factors: lack of IT knowledge & support; small OTL CoP at Emory; IT continuously changes; success of intervention is highly dependent on ID fidelity; confounding variables include contributions from other courses, students' prior content knowledge, and students' unique clinical experiences.

Specifically, the literature review has focused and refined the scope of the POP, and abetted the development of research questions that will enable me to:

- Develop an understanding of the approaches to learning anatomy utilized by students studying within medical sciences curricula globally.
- Develop an understanding of the approaches to learning anatomy utilized by AA students studying at Emory University.

- Develop an understanding of students' perceptions of learning anatomy.

Research Questions

Guiding research questions are listed here, along with corresponding literature review questions, concepts, and constructs. All statements and questions implicitly refer to learning anatomy in medical science courses.

1. Concept: If the enactive mode of dissection and the manipulative of cadaver specimens are eliminated, what alternative TLM may provide similar, sufficient means for students to construct knowledge?

    Construct: Using Bruner's information processing model of three modes of representation based on cognitive theory, the materials can be categorized as enactive, iconic, or symbolic.

    LRQ: What TLM have been shown to affect positive learning outcomes?

    RQ1: What TLM does the EUAAP utilize?

    RQ2: What TLM are available at EU, EUSOM, and EUAAP?

2. Concept: If the activity of cadaver dissection is eliminated, what alternative IM may provide similar, sufficient means for students to actively construct knowledge?

    Construct: Using social constructivist theory, the instructional methods can be categorized as teacher-centered teaching, student-centered learning, facilitating, scaffolding, modeling, creating schemata, and verbalization of inner thoughts.

    LRQ: What IM have been shown to affect positive learning outcomes?

    RQ3: What IM does the EUAAP utilize?

    RQ4: What IM could be incorporated into the EUAAP?

3. Concept: Students' attitudes, motivation, beliefs affect their engagement, learning, and performance (Bransford et al., 2000; McLaughlin et al., 2013).

Construct: Because students are stakeholders and participants, their perceptions of TLM and IM are informative from an educational psychology metacognitive/affective theory perspective.

LRQ: What are students' perceptions of various TLM?

LRQ: What are students' perceptions of various IM?

RQ5: What are students' perceptions of the TLM utilized by the EUAAP?

RQ6: What are students' perceptions of the IM utilized by the EUAAP?

RQ7: What are faculty perceptions of the TLM utilized by the EUAAP?

RQ8: What are faculty perceptions of the IM utilized by the EUAAP?

Methodology

Educational Setting

BAHS 500 Human Anatomy with Cadaver Laboratory is a graduate level course taught to EUAPP students during their first fall semester. Anecdotally, BAHS 500 is considered by AA students to be one of the most rigorous courses, which is attributed to the large amount of material covered and the short amount of time allotted to master it (R. Hall, personal communication, October 4, 2013; R. Brouillard, personal communication, March 13, 2014).

BAHS 500 course objectives are to provide students with TLM and instructional methods such that they may: (a) construct a broad, solid, knowledge base of human anatomy upon which to build further scientific medical knowledge in subsequent EUAAP coursework; (b) develop schema for critical thinking and clinical decision-making; (c) transfer and apply that knowledge to the clinical practice of anesthesia resulting in safe and effective patient care; and (d) develop schema for lifelong learning (Pettus & Mitchell, 2013).

Stakeholders

Because the EUAAP directors have called for the anatomy course to be redesigned, I consider them to be the pre-eminent stakeholders in the needs assessment. In descending order of importance are EUSOM anatomy course directors, followed by EUAAP and EUSOM faculty, and EU administrators. Table 4 lists stakeholders and their organizational roles; a detailed analysis of each stakeholder is presented in Appendix B. These stakeholders will receive the needs assessment report and subsequently approve or reject recommendations for changes to the course.

Table 4

Stakeholder Identification

Stakeholder	Organizational Role
Sally Mitchell, MMSc	ANES 525 Course Director
	ANES 525 Instructor
	Instructional Designer
	Process Champion
	Analysis Facilitator
Richard Brouillard, ScD, MMSc	EUAAP Program Director
	Executive Sponsor
	Evaluation Sponsor
Edward Pettus, PhD	BAHS 500 Course Director
	EUSOM Faculty
Katherine Monroe, PhD, MMSc	EUAAP Associate Program Director
J. Ron Hall, MD, MMSc	EUAAP Medical Director
Laureen Hill, MD, MBA	Department of Anesthesiology Chair
EUAAP Faculty and Staff	Colleagues of CD
AA Students	Target Population

EUAAP students are stakeholders seeking quality education and value for their time and tuition. Thus, they are primary drivers of this paradigm shift (Smith, Martinez-Álvarez, & McHanwell, 2014). Additionally, they are customers to whom I am providing a service, and soon, they will be my clinical colleagues.

The most distant group of stakeholders is patients because they are recipients of healthcare services provided by AAs educated at Emory. However, impact of changes made to BAHS 500 on patients and patient care are beyond the scope of this study.

Participants

In addition to being stakeholders, students are also participants, inputs, and the target audience. Two currently enrolled cohorts have competed BAHS 500, and the upcoming cohort (matriculating June 2014) will enroll in BAHS 500 Fall 2014. Demographics for cohorts that matriculated in 2012 and 2013 are listed in Table 5. There were 75 total potential student respondents.

Table 5

Emory AA Program Student Demographics

	Cohort	
Item	2012	2013
GPA – Prerequisites	3.40	3.48
GRE	1125	1158
Class Size	37	38
Gender – Male %	48	44
Gender – Female %	52	56
Age at Matriculation	27	30

Note: Adapted from Emory University School of Medicine Master of Medical Science in Anesthesiology Program (2013). Admissions. Retrieved from http://med.emory.edu/aa_program/admissions/matriculant_statistics.html

Design

The study involved EUAAP students and faculty, and received ethical approval from Johns Hopkins University. The study examined BAHS 500 with regard to TLM and IM. It consisted of descriptive research to document the status quo, and qualitative research to develop a deep understanding of student perceptions. Figure 2 is a causal diagram depicting perceived influences on student achievement and perceptions.

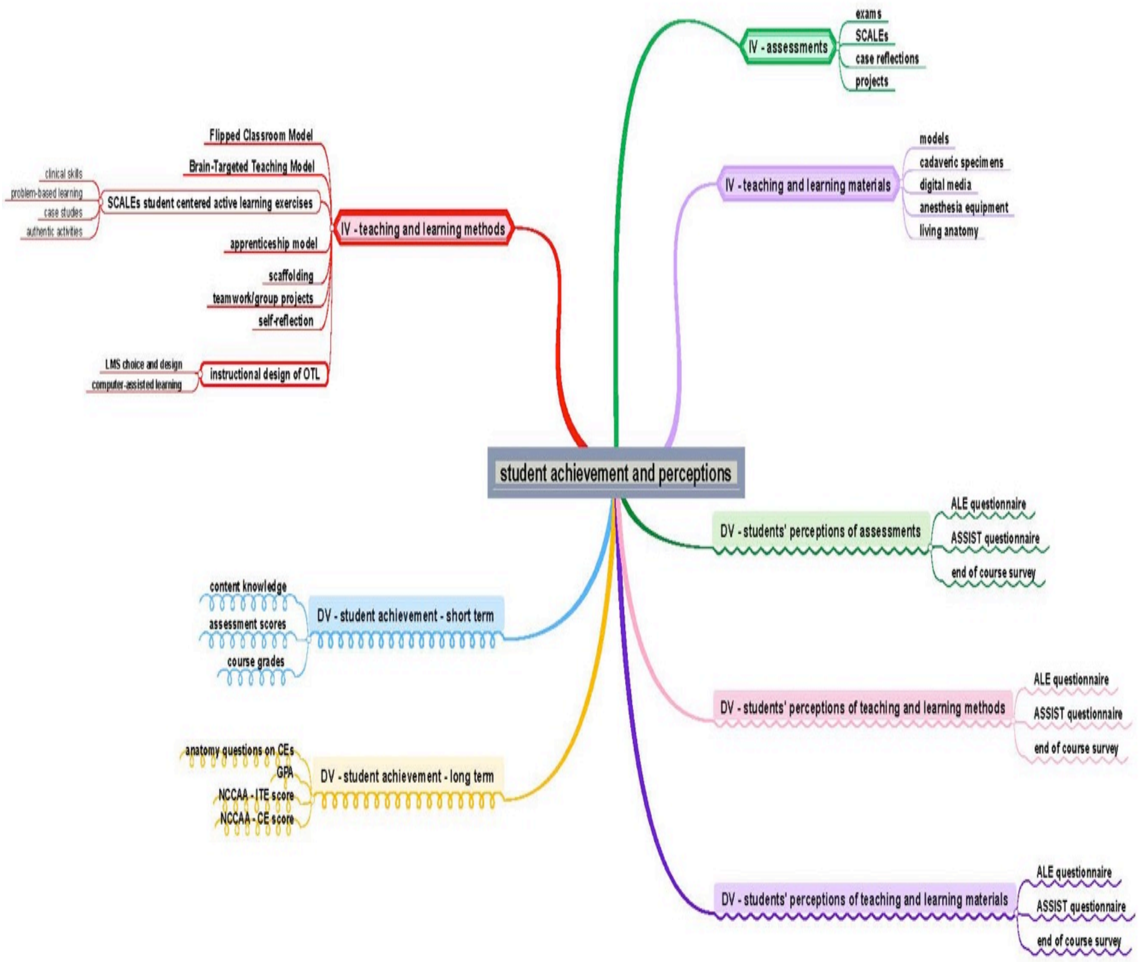


Figure 1. Causal diagram and explanation. This causal diagram lacks arrows among variables because I think that all three of the independent variables (ID) affect each other from the perspective of iterative course design, and they also affect all five of the dependent variables (DV) through direct causal relationships and feedback loops. Additionally, with the exception of long-term student achievement, all five of the DV affect each other in feedback loops. Long-term student achievement would not be able to contribute to end-of-course student perceptions as measured in this study due to linear progression and time limitations. Arrows were omitted to permit clarity when reading the text.

Variables

TLM are the resources an instructor uses to deliver instruction, and to assist and support learning (University College Cork, 2014). TLM (see Table 6) occupy a major role in making knowledge accessible to learners, and can motivate students to engage with knowledge in different ways (University College Cork, 2014).

Table 6

Teaching and Learning Materials Utilized in Anatomy Courses

TLM	Mode of Representation	Studies Cited
Cadavers	Enactive	Cuddy et al., 2013; Korf et al., 2007 Older, 2004
Virtual cadavers	Iconic Symbolic	Adamczyk et al., 2009; Codd & Choudhury, 2011; Sugand et al., 2010; Tworek et al., 2013
Plastinated specimens	Enactive	Fruhstorfer et al., 2011; Latorre et al., 2007; McLachlan et al., 2004; Moore et al., 2011; Sugand et al., 2010
Anatomic models	Enactive	McLachlan et al., 2004; Pawlina & Drake, 2013; Preece et al., 2013; Sugand et al., 2010
Digital media	Iconic Symbolic	Brenton et al., 2007; Carleton, 2012; Gould et al., 2008; Husmann et al., 2009; McLachlan et al., 2004; O'Byrne et al., 2008; Salajan et al., 2009; Sugand et al., 2010
Medical images	Iconic	Brenton et al., 2007; Gunderman & Wilson, 2005; Ivanusic et al., 2010; Machado et al., 2012; McLachlan et al., 2004; Sugand et al., 2010
Medical documents	Symbolic	Brenton et al., 2007; Gunderman & Wilson, 2005; McLachlan et al., 2004; Sugand et al., 2010

IM are the interactions between instructors and students, and between students and TLM. These methods (see Table 7) afford students opportunities to learn, and can be placed on a continuum from teacher-centered teaching (i.e. lectures), where instructors hold the locus of control, to student-centered learning (i.e. independent study), where students hold the locus of control (Atkins & Brown, 1988).

Table 7

Instructional Methods Utilized in Anatomy Courses

Methods	Studies Cited
Dissection and prosection	Cuddy et al., 2013; Korf et al., 2007; Older, 2004
Specimens and models	Adamczyk et al., 2009; Fruhstorfer et al., 2011; Johnston & McAllister, 2008; Latorre et al., 2007; McLachlan et al., 2004; Pawlina & Drake, 2013
Flipped classroom, OTL, and CAL	McLaughlin et al., 2014; Rehman et al., 2012; Rizzolo et al., 2010
Problem based learning	Carraccio et al., 2002; McLaughlin et al., 2014; Rizzolo et al., 2010; Sugand et al., 2010
Case studies	Brenton et al., 2007; Carraccio et al., 2002; McLaughlin et al., 2014; Philip et al., 2008; Rizzolo et al., 2010
Clinical skills	Carraccio et al., 2002; Gunderman & Wilson, 2005; Philip et al., 2008; Rizzolo et al., 2010

Note: All methods can include student-centered learning, applied learning, facilitating, scaffolding, modeling, creating schemata, and verbalization of inner thoughts.

Perceptions of TLM and IM are inherently more difficult to define and measure. The literature review resulted in several studies showing positive results for various student perception surveys. The literature review identified two evidence-based, validated survey questionnaires designed to ascertain students' perceptions and experiences: (a) Approaches and Study Skills Inventory for Students (Entwistle, 1997) and (b) the Anatomy Learning Experiences Questionnaire (Smith et al., 2014).

Instruments

Because students' learning approaches and subsequent satisfaction and are dependent upon the learning environment, investigating and seeking understanding of how AA students approach learning is important to informing course redesign (Smith et al., 2014). For the needs assessment, an end of course survey instrument was developed and administered to students who had taken BAHS 500 in Fall 2013.

The Anatomy Learning Experiences Questionnaire (ALE) Likert-scale 31-question inventory was designed to ascertain students' perceptions and experiences of learning anatomy (Smith et al., 2014). The ALE is divided into five clusters:

- The activities students prefer to do to learn anatomy.
- Students' experiences and feelings about working on cadavers.
- The problems students encountered.
- How students currently use their anatomy knowledge.
- Students' overall perceptions of anatomy (p. 272).

The ALE instrument had been previously validated and reported in several articles (Smith & Mathias, 2007; 2009; 2010; 2011).

Entwistle (1997) developed the Approaches and Study Skills Inventory for Students (ASSIST), a Likert-scale 52-question inventory designed to ascertain students' approaches to learning. It was subsequently adapted with permission to insert the term *anatomy* as deemed appropriate by Smith et al. (2014). The two instruments were merged into one Likert-scale inventory. As demonstrated by Smith et al. (2014), use of the ALE made it possible to relate the ASSIST inventory to the context of learning anatomy.

Written permission was obtained from Dr. Claire F. Smith (personal communication March 19, 2014) for use and adaptation of the ALE-ASSIST instrument (see Appendix C). My background knowledge of BAHS 500, course documents, and literature review served as the basis for adaptation of the ALE-ASSIST instrument to reflect germane instructional strategies and student experiences in BAHS 500. I developed a Likert-scale 63-question inventory, Student Perceptions of Anatomy BAHS 500 (see Appendix D). The instrument focused on students' perceptions of: instructor provided TLM, IM utilized by the instructor, and how well anatomy topics were correlated to anesthesia practice (see Table 8).

Table 8

Needs Assessment Data Collection Matrix BAHS 500

Variable	Type	Operational Definition	Valid Indicator
Teaching and learning materials	Independent	Physical and virtual learning resources provided by Emory	Course syllabus; evidence-based best practices
Instructional methods	Independent	Pedagogy utilized to convey content to students for the in-class portion of the blended course	Course syllabus; evidence-based best practices; teaching and learning theories
Students' perceptions of TLM	Dependent	Students' opinions of the effectiveness of TLM	Adapted ALE questionnaire
Students' perceptions of instructional methods	Dependent	Students' opinions of the effectiveness of pedagogy	Adapted ALE questionnaire

Data Collection Methods

All potential participants (n = 75 students) were invited by e-mail to participate in the study. Individuals who decided to participate were provided with an electronic Participant Informed Consent (see Appendix E) and, if they agreed to participate, were instructed to complete the electronic questionnaire, Student Perceptions of Anatomy BAHS 500. A Survey Monkey account held by the EUAAP was used to compose and administer the survey. From this sample, data from 12 usable surveys (17% of students) were included in the analysis.

Discussion of Results and Initial Findings

Only 17% of students responded, despite three emails and four in-person requests over a period of 20 days. I attribute the low response rate to operator-errors and user-errors with the Survey Monkey software. It was my first attempt with the software, and by forcing answers to several demographic questions, glitches surfaced during a trial with ten students. I mistakenly thought I had fixed the problem, but rather just created a new problem that became evident during a second trial with six students. I did resolve the issue, but had to delete the 16 trial responses. Unfortunately, those 16 students were under the impression that they had completed the survey. It was not until I spoke with several of those students that I realized their confusion. Furthermore, the time frame coincided with end of semester assignment due dates and final examinations for five courses.

All student respondents either agreed (58%) or somewhat agreed (42%) with the statement: *I found clinical concepts taught/explained/presented by clinicians an effective way of learning anatomy*. All student respondents perceived learning anatomy as important for their future career, and rated clinically based teaching as the most effective instructional method. Self-directed computer-assisted learning ranked second, and 25% of students rated traditional lectures as the least effective instructional method.

The review of course documents was non-productive because it merely confirmed what I already knew about TLM and IM utilized in BAHS 500 (see Tables 9 and 10).

Table 9

TLM Available and/or Utilized in BAHS 500 Fall 2013

TLM	Mode of Representation	Available	Utilized
Cadavers	Enactive	Yes	Yes-phasing out
Virtual cadavers	Iconic, Symbolic	No	No
Plastinated specimens	Enactive	No	No
Anatomic models	Enactive	Yes	Yes
Digital media	Iconic, Symbolic	Yes	Yes– minimally
Medical images	Iconic	Yes	Yes– minimally
Medical documents	Symbolic	Yes	Yes– minimally

Note: Adapted from "BAHS 500 Basic Allied Health Sciences, Human Anatomy with Cadaver Laboratory, Course Syllabus Fall 2013" by E. Pettus and S. A. Mitchell. 2013. Emory University School of Medicine and Emory AA Program. Unpublished.

Table 10

Instructional Methods Available and/or Utilized in BAHS 500 Fall 2013

Method	Available	Utilized
Dissection and prosection	Yes-phasing out	Yes
Specimens and models	Yes	Yes
Flipped classroom	No	No
OTL	Yes	No
CAL	Yes	No
Problem based learning discussions	No	Yes
Case studies	No	Yes
Clinical skills	Yes	Yes

Note: Adapted from "BAHS 500 Basic Allied Health Sciences, Human Anatomy with Cadaver Laboratory, Course Syllabus Fall 2013" by E. Pettus and S. A. Mitchell. 2013. Emory University School of Medicine and Emory AA Program. Unpublished.

Conclusions

The survey could be wiped clean and re-administered during the summer semester to both AA cohorts. Of course, that would only occur after I explore the finer details of how Survey Monkey operates. My goal is to get enough responses to run SPSS. After the implementation phase for the upcoming cohort of 2015, the plan is to hold an in-class session to explain informed consent, request their participation, and debrief on the course itself such that the students are more likely to participate in the survey.

Chapter 4: Intervention Literature Review

Applying the Flipped Classroom Model Through the Lens of the Brain-Targeted Teaching Model: Examination of Theories, Models, and Interventions for Instructional Design of ANES 525

The Flipped Classroom Model and the Brain-Targeted Teaching Model

As demonstrated by the needs assessment, students value clinically relevant teaching methods more so than traditional lectures. Consequently, the process of transforming BAHS 500 into ANES 525 continues with a secondary consideration and examination of the literature on two identified, feasible interventions: the flipped classroom model, and the Brain-Targeted Teaching Model. Relevance of these interventions to AA education and ways in which I can affect implementation are examined through a teaching-leadership perspective.

In an editorial article, Prober and Khan (2013) proposed a pedagogical model for medical education through incorporation of three key processes: "building a framework of core [medical] knowledge; embedding the knowledge in richly interactive, compelling, and engaging formats; and encouraging in–depth pursuit of knowledge in some, but not all, domains," by leveraging the strengths of the school and the interests of the learners (p. 1408). The authors recommend implementing the flipped classroom model to shift core knowledge content to an LMS, thereby freeing up classroom time for applied learning exercises, and focusing instructors' efforts on engaging students in higher-order thinking (Prober & Khan, 2013).

The Stanford Medicine Interactive Learning Initiative, of which Prober is a faculty member, listed examples of applied learning such as PBL, team-based learning, simulation, case studies, and role-playing (Prober & Khan, 2013). These activities are considered IM which: (a) foster critical thinking and problem solving; (b) encourage higher-order thinking via synthesis, analysis, and evaluation; and (c) lend to continual formative assessments by instructors (Bonwell & Eison, 1991; Donner & Bickley, 1993; Drake et al., 2009; Hartling, Spooner, Tjosvold, & Oswald, 2010; Imafuku, Kataoka, Mayahara, Suzuki, & Saiki, 2014; Kassirer, 2010; Maudsley & Strivens, 2000; McLaughlin et al., 2014; Philip, Unruh, Lachman, & Pawlina, 2008; Pierce & Fox, 2012; Prober & Khan, 2013; Rizzolo et al., 2011; Rizzolo et al., 2010; Savery & Duffy, 1995; Sivagnanam, Saraswathi, & Rajasekaran, 2009; White, 2007; Yiou & Goodenough, 2006). It is through implementation of the flipped classroom model in medical school courses that leaders in medical education aim to enrich learning, improve learning outcomes, increase student satisfaction, and prepare students with 21^{st} century skills for the practice of 21^{st} century medicine (McLaughlin et al., 2014; Pierce & Fox, 2012; Prober & Khan, 2013; Rizzolo et al., 2011; Rizzolo et al., 2010; White, 2007; Yiou & Goodenough, 2006).

As course director and instructor of a graduate level medical science anatomy course, these too are my goals. In an effort to explore and deeply understand credible interventions directed toward feasible solutions to the Problem of Practice, this intervention literature review focuses on: (a) the flipped classroom model as an instructional framework for higher education; (b) specific teaching and learning methods of applied learning relevant to anatomy and anesthesiology; (c) ways the Brain-Targeted

Teaching Model can inform these two elements of instruction and course design; (d) implications of these interventions from a teaching-leadership perspective; and (e) how I can utilize leadership principles to maximize impact and positive outcomes for my students, program, and profession.

The Flipped Classroom

The traditional classroom model operates with instructor-centered, lecture-based, introduction of basic content knowledge followed by homework assignments designed to strengthen understanding and application of basic knowledge. The flipped classroom model switches the learning activities with respect to time and physical location: Students do homework prior to attending class, such as reading, watching videos, watching screen casts of prerecorded lectures, and engaging in computer-assisted learning, and they arrive to class prepared to engage in applied learning (Sams & Bergmann, 2013). Pioneered in 2007 by science teachers Aaron Sams and Jonathan Bergmann at Woodland Park High School in Colorado (Fulton, 2012), the flipped classroom is an instructional framework focused on student-centered learning through best use of in-class time (Sams & Bergmann, 2013).

As a guide for instructors, Sams and Bergmann (2013) posed the following question: “Where in the learning cycle do your students most need you face-to-face?” (p. 16) In my opinion, AA graduate students should be capable of acquiring basic anatomy knowledge independently, as demonstrated by their completion of a baccalaureate degree and pre-medicine prerequisite courses. Therefore, the value-added by clinical instructors is needed during the understanding and applying knowledge phase of learning (Prober & Khan, 2013; Sams & Bergmann, 2013).

Sams and Bergmann (2013) then asked a second guiding question: "Using technology, what can you remove from class to increase value of face-to-face time?" (p. 17). The two teachers asserted their model worked especially well for courses with large quantities of content on the low end of Bloom's Taxonomy (Bloom, 1956; Bouchard, 2011; Sams & Bergmann, 2013). Instructors and students alike colloquially describe the basic medical science course of AA anatomy, as rote memorization and regurgitation of vast amounts of terminology describing structures of the human body (E. Pettus, personal communication, March 25, 2014). Thus, I consider this course well suited to flipping in regard to shifting basic content acquisition from instructor-centered, lecture-based, in-class presentations to student-directed learning through digital media presentations accessible via an LMS. But what does the literature report about digital media as a substitute for in-person lectures and the learning afforded to students?

Although medical educators have been slow to adopt the flipped classroom model and resultant online teaching and learning, empirical studies support the efficacy of both practices. Solomon, Ferenchick, Laird-Fick, and Kavanaugh (2004) conducted a randomized trial of third-year internal medicine clerkship students who either (a) attended a live lecture series (*resident learners*), or (b) watched a digital video version of the same lecture series (*distance learners*). The authors hypothesized that digital lectures could promote content mastery at the same or similar level as live lectures (Solomon et al., 2004). They anticipated that replacement of live lectures would afford all students the same learning opportunities, allow students to view the presentations at their convenience, and save time and travel costs for students and faculty (Solomon et al., 2004). Students completed a posttest for each of six lectures to assess content mastery, and no significant difference was found between scores of the two groups (Solomon et al., 2004). Students in the distance learners group were queried about their perception of the experience, and reported high satisfaction for choosing viewing time, choosing viewing repetition, and avoiding travel (Solomon et al., 2004). However, the cited disadvantages included lack of opportunities to ask questions of the presenter and engage in discussions (Solomon et al., 2004). Fortunately, AA students will have the opportunity to discuss and ask questions during f2f class time.

Since the 2004 study by Solomon et al., there have been vast changes and improvements in the production, quality, and delivery of digital media. These new technologies afford students resources for student-directed learning, which allows them to come to class better prepared to engage in applied learning (Chu, Young, Zamora, Kurup, & Macario, 2010; Codd & Choudhury, 2011; Husmann et al., 2009; Ivanusic et al., 2010; Kurup & Hersey, 2013; Machado et al., 2013; Pierce & Fox, 2012; Prober & Khan, 2013; Schneps et al., 2014). Several recent studies of medical science courses have demonstrated increased student satisfaction post incorporation of digital media (McLaughlin et al., 2014; Pierce & Fox, 2012; Rizzolo et al., 2011; Rizzolo et al., 2010) and increased assessment scores (Pierce & Fox, 2012; Rizzolo et al., 2011; Rizzolo et al., 2010) following implementation of flipped classroom and applied learning.

As a university instructor, I have at my disposal multiple OTL and digital media resources. EU provides Blackboard Learn as an LMS platform, lists self-help resources on its website (Emory Center for Digital Scholarship [ECDS], 2014a), and operates the Emory Center for Digital Scholarship to assist faculty and staff (ECDS, 2014b). Additionally, my experience at Johns Hopkins University School of Education will inform development of ANES 525 through the lens of a graduate student enrolled in an online program of study.

Furthermore, I anticipate the specialization courses, (a) Instructional Design for Online Teaching and Learning, and (b) Instructional Design Theories and Models (Johns Hopkins University School of Education, 2014a), will provide me with opportunities to develop deeper understanding of these and other currently unknown topics, just as the Mind, Brain, Science, and Learning course (Johns Hopkins University School of Education, 2014b) enlightened me on the subject of neuroeducation. A complementary intervention, The Brain-Targeted Teaching Model by Mariale Hardiman (2012), could serve as a pedagogical framework to guide the development and implementation of the flipped classroom intervention.

The Brain-Targeted Teaching Model

Instructional design of both the online environment and classroom can be informed by evidence-based research in neuro and cognitive sciences (E. Gregory, Hardiman, Yarmolinskaya, Rinne, & Limb, 2013; Hardiman, 2012; Hardiman, Rinne, & Gregory, 2012; Hardiman & Whitman, 2014; L. Rinne, Gregory, E., Yarmolinskaya, J., & Hardiman, M., 2011). Developed by Hardiman (2012) as a pedagogical framework linking neuroscience with neuroeducation, Brain-Targeted Teaching (BTT) focuses on teaching and learning processes aimed at engaging students in deep and meaningful learning to cultivate critical and creative thinking skills, and guides development of instructional strategies through six Brain-Targets (BT):

1. Establishing the emotional climate for learning.
2. Creating the physical learning environment.

3. Designing the learning experience.
4. Teaching for mastery of content, skills, and concepts.
5. Teaching for the extension and application of knowledge.
6. Evaluating learning (pp. 27-29).

Although BTT was developed as a model for k-12 education, the field of higher education has produced comparable models. Prober and Khan (2013) constructed a pedagogical model directed toward medical educators in which they advocated incorporating teaching and learning processes to (a) build a framework of core medical knowledge, (b) embed the knowledge in engaging and interactive formats, and (c) encourage in-depth purist of knowledge.

In an inspiring presentation, Sir Ken Robinson encouraged educational leaders to face and embrace the leadership challenges of today's education systems (The Royal Society for the Encouragement of Arts Manufactures and Commerce Animate, 2014). Rather pointedly, he asked: "How do we educate 21st century kids to join the workforce?" (The Royal Society for the Encouragement of Arts Manufactures and Commerce Animate, 2014) From the standpoint of an aspiring medical education leader, I reply: By adopting the flipped classroom model through the lens of the Brain-Targeted Teaching Model. Hence, each of the six Brain-Targets will be explored from the perspectives of medical education and educational leadership, as supported by evidence-based best practices literature, to depict what BTT could look like in ANES 525.

Brain-Target One: Establishing the emotional climate for learning. Hardiman (2012) explains the importance of creating a positive learning environment. Based on neuro and cognitive science research that demonstrates the significant effects of emotion on attention, memory, and cognition, she suggests that instructors foster personal connections with and among students, afford students a sense of control over their learning, and include humor to reduce stress (Hardiman, 2012). In what ways can these recommendations be accomplished via implementation of the flipped classroom model of instruction?

Flipping the classroom has been shown to provide students with a sense of increased control over both self-directed, out of the classroom learning and student-centered, in class learning because the ownership of learning has been reassigned from instructor to students (Kurup & Hersey, 2013; McLaughlin et al., 2014; Philip et al., 2008; Pierce & Fox, 2012; Prober & Khan, 2013; Rizzolo et al., 2011; Rizzolo et al., 2010; Sams & Bergmann, 2013; White, 2007; Yiou & Goodenough, 2006). The shift to in class student-centered learning presents the opportunity to incorporate group projects through which student-student and student-instructor personal connections can be constructed (Hardiman, 2012; Prober & Khan, 2013; Sams & Bergmann, 2013). Additional opportunities for deep student-instructor connections present as the instructor-come-facilitator is free to engage in personalized teaching moments (Hardiman, 2012; Krupp & Hersey, 2013; Prober & Khan, 2013; Sams & Bergmann, 2013).

Furthermore, this instructional model serves to initiate, scaffold, and develop lifelong learning (Kurup & Hersey, 2013; McLaughlin et al., 2014; Philip et al., 2008; Pierce & Fox, 2012; Prober & Khan, 2013; Rizzolo et al., 2011; Rizzolo et al., 2010; Sams & Bergmann, 2013; White, 2007; Yiou & Goodenough, 2006). Guiding students along the pathway to becoming lifelong learners is a primary goal of the EUAAP (2013) curriculum. In the form of continuing medical education credits (CMEs), it is a required component of AA national certification (NCCAA, 2009a), state licensure (Georgia Composite Medical Board, 2014), and hospital credentialing (Emory Healthcare, 2014). Perhaps most poignantly, lifelong learning is necessary to keep current with medical advancements and clinical practice guidelines so that an AA may provide the best possible care to patients (EUAAP, 2013).

To create a positive emotional environment, foster these specific personal relationships, and maintain both over time, requires engagement of leadership skills (House & Aditya, 1997). The genre of neocharismatic leadership theories edified common leader behaviors and effects, and accompanying dependent variables of follower (i.e., student) satisfaction and performance (House & Aditya, 1997). Leader (i.e., instructor) effects, such as student self-esteem, motivation, commitment, trust, arousal, and emotions, are positively affected by emotionally appealing instructor behaviors, such as high self-esteem, role modeling, image building, supportive behavior, and cognitively oriented behavior (House & Aditya, 1997). I am embarking on my fifth year as a didactic instructor, have been a clinical instructor for fifteen years, and prior to that, a graduate teaching assistant for anatomy and physiology courses. Neocharismatic leader behaviors (House & Aditya, 1997) are those that I have continually employed throughout my teaching career, and which I anticipate will serve to achieve the same desired effects within ANES 525.

Brain-Target Two: Creating the physical learning environment. Many factors in the physical environment of the classroom have effects on attention, engagement, and learning (Hardiman, 2012). Posner, Rothbart, and Tang (2013) described three neural networks relating to attention: (a) alerting network, which refers to initiation of attention to external events versus internal thoughts; (b) orientating network, which refers to engagement and concentration through simultaneous amplification of target input and reduction of distractions; and (c) executive network, which refers to conflict resolution and self-regulation of emotion, cognition, and behavior. Parallel to the recommendation by Hardiman (2012) that students should be encouraged to take ownership of their physical (i.e., external) environment, Posner et al. (2013) emphasized the importance of students taking ownership of their mental (i.e., internal) environment.

To apply BT2, Hardiman (2012) suggested that instructors purposefully design the classroom environment to take advantage of novelty, decrease stress, and minimize distractions. The EUAAP has adopted Kolb's (1984) experiential learning theory in several courses, and so students are accustomed to the learning process of experience, reflect, conceptualize, and experiment through participating in student-centered applied learning exercises (e.g., SCALEs) such as human patient simulation and PBL (EUAAP, 2013). All of this training is to prepare students to function as healthcare providers in the clinical setting, and so the goal is to create an authentic classroom environment (EUAAP, 2013). However, it is still a classroom, not an operating room, and cannot replicate the inherently, culturally diverse setting of a hospital. I purport that the clinic/hospital is a culturally diverse setting, because there are distinct and unique attributes (i.e., communication, behaviors, expectations, schemas, and medical professionalism norms) that differentiate it from other institutions, just like a country or a school (Ng, Van Dyne, & Ang, 2009; Pauliene, 2012). Therefore, from a global leadership perspective, my degree of cultural intelligence (CQ) is expected to influence the students' acclimation, adaptation, and assimilation into the culture of their future profession (Ng et al., 2009;

Pauliene, 2012). My baseline metacognitive, cognitive, motivational, and behavioral intelligences determine the potential qualitative and quantitative levels of CQ that I could demonstrate and transfer to my students, which will affect the students' capabilities to function and manage themselves effectively in the hospital environment (Ng et al., 2009). In addition to the emotional and physical environments, the learning experiences and their efficacy could be influenced by CQ (Ng et al., 2009).

Brain-Target Three: Designing the learning experience. The traditional method of teaching anatomy has been dissection of cadavers and lectures by professors (Drake et al., 2009; Gunderman & Wilson, 2005; Korf et al., 2008; McLachlan et al., 2004; Mitchell et al., 2011; Older, 2004; Persaud, 1984; Sugand et al., 2010). This approach is generally considered to involve rote memorization of an ever-increasing mass of essential anatomical and medical details (Yiou & Goodenough, 2006). The paradigm shift in medical education acknowledges these unrealistic expectations, and seeks to preferentially affect the development of 21st century skills and positive attitudes toward lifelong learning (Kurup & Hersey, 2013; McLaughlin et al., 2014; Pierce & Fox, 2012; Prober & Khan, 2013; Rizzolo et al., 2011; Rizzolo et al., 2010; White, 2007; Yiou & Goodenough, 2006).

To accomplish these goals, Harvard Medical School incorporated PBL pedagogy into its anatomy curriculum (Yiou & Goodenough, 2006). Students: (a) are introduced to topics through micro-lectures; (b) then research and discuss clinical cases in small groups with a faculty facilitator; and subsequently (c) attend histology, radiology, and dissection laboratories to learn structure and function (Yiou & Goodenough, 2006). Clinical cases focused on pathologies, injuries, and surgeries provide motivation for students to assume responsibility for acquiring anatomical knowledge necessary to solve real-world clinical problems (Yiou & Goodenough, 2006). This aligns with Hardiman's (2012) BT3 recommendations and serves as a seminal article for design and development of ANES 525: Essentially, the article provides a template of how to intercalate basic science content knowledge with big picture connections organized around core clinical concepts (Yiou & Goodenough, 2006).

By maintaining focus on the big picture, examples of PBLs germane to ANES 525 are preoperative anesthetic consultation and assessment (e.g., taking a patient's medical history and physical examination) and anesthetic plan development (e.g., outlining appropriate case management strategies and interventions tailored to the patient). Both clinical activities are authentic, routine, and essential patient care skills required of AAs (AAAA, 2013; EUAAP, 2013). In addition, these activities function as authentic concept maps to provide visual representation of the importance of anatomy content knowledge to the practice of anesthesia. Developing competency in these activities is an overarching goal of the EUAAP (2013) curriculum and current medical education pedagogy (Kurup & Hersey, 2013; McLaughlin et al., 2014; Pierce & Fox, 2012; Prober & Khan, 2013; Rizzolo et al., 2011; Rizzolo et al., 2010; White, 2007; Yiou & Goodenough, 2006). To further students' progress along the learning continuum from novice toward competent practitioner, teaching methodologies aimed at cultivating this transformation are next considered as possible interventions.

Brain-Target Four: Teaching for mastery of content, skills, and concepts. Competency, or in the context of the BTT model, *mastery*, is a neurophysiological process that involves encoding, retention, and retrieval of short-term, working, and long-term memories (Hardiman, 2012). According to Hardiman (2012), mastery can be accomplished through incorporation of pedagogical methods that require active retrieval of knowledge, application of knowledge, critical-thinking, or creative problem solving. When describing these methods within the context of ANES 525, I refer to them collectively as *student-centered applied learning exercises* (SCALEs). Specific examples of SCALEs include PBL, case studies, clinical skills, and critical reflections. Empirical studies (Philip et al., 2008; White, 2007) and detailed descriptive reports (Hartling et al., 2010; Imafuku et al., 2014; Lee, Blackwell, Drake, & Moran, 2014; Maudsley & Strivens, 2000; Yiou & Goodenough, 2006) provide PBL and case study templates, examples, and ideas for SCALEs as practical interventions.

For the purpose of the POP, I define PBL for AA students as learning anatomy through solving problems within the context of patient cases: intercalating anatomy with clinical diagnoses, surgical procedures, and anesthetic case management. PBL allows students to assume responsibility for their learning, engage in independent research, analyze data, and reflect on their own clinical and didactic learning experiences in order to perform critical thinking and problem solving commensurate with authentic clinical activities (Hartling et al., 2010; Imafuku et al., 2014; Lee et al., 2014; Maudsley & Strivens, 2000; Philip et al., 2008; White, 2007; Yiou & Goodenough, 2006). For example, students could be assigned to construct case management scenarios and clinical documents using all six of Bloom’s Taxonomy levels from a top-down approach: evaluating, synthesizing, analyzing, applying, defining, and memorizing (Bloom, 1956; Bouchard, 2011; Yiou & Goodenough, 2006). Within the context of a student-centered learning environment, PBL also gives instructors the flexibility to meet the learning needs of all their students, and gives students multiple methods to have their needs met (Hardiman, 2012; Hartling et al., 2010; Imafuku et al., 2014; Lee et al., 2014; Maudsley & Strivens, 2000; Yiou & Goodenough, 2006). Instructors can facilitate and scaffold learning to each student's or group's needs, which is especially helpful when students have different levels of prior knowledge and different levels of motivation for each topic (Hardiman, 2012; Hartling et al., 2010; Imafuku et al., 2014; Lee et al., 2014; Maudsley & Strivens, 2000; Yiou & Goodenough, 2006).

Brain-Target Five: Teaching for the extension and application of knowledge - creativity and innovation in education. Consistent with overarching EUAAP (2013) goals, the following statement also resonates with the specific objectives of ANES 525: "Being able to successfully adjust to unexpected and frequent changes requires flexible application of prior knowledge" (E. Gregory et al., 2013, p. 45). That is, I strive to provide AA students with instruction in anatomy that affords them both the resources to acquire content knowledge and various opportunities to develop adaptive expertise. I think these objectives could be met through authentic and neocharismatic leadership practices (House & Aditya, 1997; Onorato, 2013). Enhanced by my utilization of these leadership skills and practices, an archetype learning experience will provide, facilitate, and encourage students to build flexible knowledge that could be applied to clinical practice (E. Gregory et al., 2013; House & Aditya, 1997; Onorato, 2013). In the following lesson on the brachial plexus (innervation of the upper limb), I will describe how I envision incorporating BT5 recommendations (Hardiman, 2012) into ANES 525.

First, students must be motivated to acquire content knowledge (E. Gregory et al., 2013). By scaffolding classroom and homework activities around clinical correlations and authentic activities, students should understand the relevance of basic anatomy, and thus strive to learn medical knowledge with routine expertise. This could be done through arts integration (E. Gregory et al., 2013; Hardiman, 2012; L. Rinne, Gregory, Yarmolinskaya, & Hardiman, 2011) via SCALEs, such as

- drawing a picture (simple ‘stick drawing’ with lines) of the brachial plexus;
- reciting the names of the anatomic structures with mnemonics;
- coloring dermatome and myotome maps of the arm; and
- weaving nerve roots to terminal branches with a brachial plexus model.

Second, students must be motivated to apply content knowledge (E. Gregory et al., 2013). I took a step back, and looked at the big picture, as recommended by Hardiman (2012), and asked myself: “What clinical activities are most important to patient care and which best exemplify what an AA does at work every day that I could use in the classroom to facilitate and scaffold development of adaptive expertise?” By implementing SCALEs, students could participate in authentic activities, such as

- collaborate (group work) in PBLs to fill out a preoperative anesthesia consult/checklist (external mediator) for patients presenting for various injuries/pathologies/surgeries (multiple response questions and alternative solutions);
- use an ultrasound machine to view the brachial plexus of a classmate in preparation for a simulated peripheral nerve block (clinical skills);
- research, reflect on, write up, and present a case scenario, which could also
    - be personalized by using a family member or ones’ self as the example patient, or

    - permit creative freedom to invent a patient/surgery/anesthesia scenario (open-ended prompt);
- predict results and effectiveness of proposed interventions (forecasting); and
- write up an anesthetic case critical reflection in which the student participated (making it personal) during clinical rotations and link it (find associations) to basic anatomy (E. Gregory et al., 2013; Hardiman, 2012).

In a pilot program by Moore et al. (2011), medical students were paired with art students to leverage interdisciplinary expertise to achieve deeper understanding of the relationships of structures and students' ability to draw the structures. Working in pairs, students used anatomy atlases, plastinated specimens, and each other's bodies as models (Moore et al., 2011). The authors anticipated the kinesthetic learning activity of progressive drawing could reinforce anatomical knowledge of structures, details, and relationships as students created their own works of art (Moore et al., 2011). On a post-program evaluation form, faculty and students indicated their appreciation for this alternate learning perspective, for how art could lend understanding to anatomy and vice versa, and the emotional satisfaction that came from creating art using the human body as subject matter (Moore et al., 2011).

In addition to drawing (Moore et al., 2011; Naug, Colson, & Donner, 2011), studies have reported the positive efficacy and student satisfaction of arts integration in anatomy curricula using clay-modeling (Herur, Kolagi, Chinagudi, R, & Patil, 2011; Kooloos, Schepens-Franke, Bergman, Donders, & Vorstenbosch, 2014; Motoike, O'Kane, Lenchner, & Haspel, 2009; Naug et al., 2011), body-painting (Finn & McLachlan, 2010; Finn, White, & Abdelbagi, 2011; McMenamin, 2008), use of fabric

(Braid, Williams, & Weller, 2012; Chan, 2010; Lisk, McKee, Baskwill, & Agur, 2014), and photography, music, yoga, and culinary (eating and drinking) arts (Dao, Yeh, Vogel, & Moore, 2014). I am prepared to construct SCALEs inclusive of arts and crafts into ANES 525. The next phase is to consider assessments aligned with SCALEs.

Brain-Target Six: Evaluating learning. Although I have good foundational ideas and evidence-based examples for SCALEs, I plan to utilize the *working backwards* method of creating assessments that represent the course objectives and then refining the SCALEs' learning affordances to align with the assessments. Hardiman (2012) endorsed the objectives for assessment as a valuable tool for enhancing and evaluating learning. She recommended that teachers: (a) provide frequent and useful feedback; (b) allow for active retrieval, which may employ scaffolding, interleaving, and spiraling of content; (c) attend to spacing feedback intervals to motivate performance; and (d) allow for creative thinking and problem solving when developing assessments (Hardiman, 2012). Grounded in neuro and cognitive science research, Hardiman and Whitman (2014) noted that intrinsic motivation for learning significantly increased when students focused on mastery of learning rather than on test performance.

For example, I found inspiration in an article by Howland (2014) that resonated with my vision for ANES 525 assessments, and which I could use as both explicit instructions to students and as a motivational phrase: "Use the tools of the discipline, your own powers of perception, and your own interests to investigate something that matters to you." (p. 33) This could be implemented and encouraged through formative assessments such as case-study critical reflections. Students could choose anesthetic cases from their personal clinical experiences, and use guided prompts germane to anesthetic case review to write a critical reflection: (a) de-construct the case; (b) make clinical anatomy-anesthesiology correlations; (c) engage in critical, creative, deductive, reflective thinking; and (d) practice clinical problem-solving (E. Gregory et al., 2013; Hardiman, 2012; Hardiman & Whitman, 2014; Howland, 2014).

Additionally, I have conceptualized a Tic-Tac-Toe assessment board (Hardiman & Whitman, 2014), comprised of the following nine SCALEs/assessments from which students could choose three to remit at the end of the semester: iBook, hypertext essay, app creation; anatomic teaching-learning model creation; PowerPoint with voice narration; PowerPoint live, oral presentation; PBL development; iMovie, YouTube video production; medical journal article written review; case-study critical reflection; and student's choice (see Appendix G). Through these assessments, project choice, self-paced project timelines, interleaving of topics, personal connection to case studies, and allowance for art integration and creativity could be afforded to all students (E. Gregory et al., 2013; Hardiman, 2012; Hardiman & Whitman, 2014; Howland, 2014; L. Rinne et al., 2011). Necessarily, evaluation and scoring rubrics for each of the assessments would be provided to students at the beginning of the semester (Hardiman, 2012).

Interventions and Implementation Strategies Specific to Instructional Design and Development of the Flipped and Blended Course

Prober and Khan (2013) recommend implementing the flipped classroom model to shift core knowledge content to an LMS, thereby freeing up classroom time for applied learning exercises, and focusing instructors' efforts on engaging students in higher-order thinking. It is through implementation of the flipped classroom model in medical school courses that leaders in medical education aim to enrich learning, improve learning outcomes, increase student satisfaction, and prepare students with 21st century skills for the practice of 21st century medicine (McLaughlin et al., 2014; Pierce & Fox, 2012; Prober & Khan, 2013; Rizzolo et al., 2011; Rizzolo et al., 2010; White, 2007; Yiou & Goodenough, 2006).

As an instructor of a graduate level medical science anatomy course, these too are my goals. However, although the previously examined literature described in depth the classroom activities, the online component of the courses was limited to vague technical statements, such as PowerPoint slides and pre-recorded videos were offloaded to an LMS, course content was integrated into an online module, or textbooks and background readings were listed online with Web links as preparatory tools (McLaughlin et al., 2014; Pierce & Fox, 2012; Prober & Khan, 2013; Rizzolo et al., 2011; Rizzolo et al., 2010; White, 2007; Yiou & Goodenough, 2006). McLaughlin et al. (2014) stated: "We believe that the actual practice of offloading content and engaging in active learning in the classroom is far more important than the specific methods we used." (p. 241) I would argue that the *specific methods* of instruction are of utmost importance when designing a flipped classroom, and should be considered for both in-class and online components. In a blended course, the materials and methods utilized for OTL are inputs and processes, and the outputs are the subsequent inputs to in-class activities. Thus, to maximize input (student preparedness) for in-class activities (student participation), as the course director, I must primarily consider the instructional design of the OTL component. Additionally, the online component must *blend* with the classroom component to create an amalgamated learning experience for the students (Garrison & Kanuka, 2004; Vaughan, 2007). Unfortunately, I fall into the category of "traditionally educated faculty [who] do not have the expertise in online learning needed to create quality online courses" (Brigance, 2011, p. 47). Through my opportunities and experiences in the Johns Hopkins EdD program, I aspire to develop OTL expertise. The readings and thought-provoking activities in which I engaged this past semester led me to consider several new research questions:

- LRQ1: With implementation of the blended learning model, in what ways can instructional theory inform the OTL component of the course?
- LRQ2: With implementation of the blended learning model, in what ways can instructional design inform the OTL component of the course?
- LRQ3: In what ways can the BTT model inform ID of the OTL component of the course?
- LRQ4: In what ways can ID positively affect student motivation, engagement, satisfaction, and learning?

In an effort to discover and deeply understand possible interventions directed toward viable solutions to the OTL/blended course components of my POP, this next literature review focuses on: (a) instructional theories and empirical models of online teaching and learning; (b) ways the BTT Model can inform the online components of OTL and course design; (c) implications of these interventions from a teaching and learning perspective; and (d) what professional development tools and support might I need as course director to maximize impact and positive outcomes for my students, program, and profession.

Distance Education and Online Teaching and Learning

Distance education (DE) occurs when the acts of teaching and learning are separated in time and place (T. Anderson & Elloumi, 2004; Garrison, 2000; Harasim, 2011; Keegan, 2013; Simonson, Smaldino, Albright, & Zvacek, 2000). Online teaching and learning (OTL) is a method of distance education in which conventional interpersonal communication is replaced by electronic and computer-based interactions via the Internet (T. Anderson & Elloumi, 2004; Garrison, 2000; Harasim, 2011; Keegan, 2013; Simonson et al., 2000). In the 21st century Knowledge Age, status post the Internet Revolution, teachers can share their knowledge community with learners through relationships initiated, cultivated, and maintained in asynchronous, technology-based, virtual environments (Harasim, 2011; Keegan, 2013). Of course, technology-based synchronous sessions and f2f sessions can also be included, and so the ratio of included delivery methods lends to further sub-types of OTL.

Blended Learning

As explained by Garrison and Kanuka (2004), blended learning spans the continuum from Web-enhanced classroom learning to fully online learning, but boundaries between adjacent delivery method categories are nebulous. The Johns Hopkins School of Education Center for Technology in Education Online Teaching and Learning (JHU SOE CTE) defined and delineated three categories of instructional delivery models for fully facilitated courses thusly:

- Online: courses which have 80-100% course delivery online.
- Blended: courses which have 30-79% course content delivery online.
- Web-enhanced: courses which meet f2f and have 1-29% course content delivery online or technology enhanced content.

This breakdown is an echo of the Sloan Consortium categories, but with minor terminology variations of hybrid versus blended, web-facilitated versus web-enhanced, and also the traditional course, which is devoid of online technology at 0% (Allen & Seaman, 2013). Regardless of the exact ratio or terms, the crux of blended learning is the seamless integration of f2f and online components of a course (Allen & Seaman, 2013; Garrison & Kanuka, 2004). Through purposeful restructuring of teaching and learning activities, instructors can direct both the online and classroom components of a course toward the course objectives (Garrison & Kanuka, 2004; Picciano, 2001; Vaughan, 2007). One objective common to BAHS 500, ANES 525, and EUAAP is to foster critical thinking (EUAAP, 2013; Pettus & Mitchell, 2013). Garrison and Kanuka (2004) contend that “to be a critical thinker is to take control of one's thought processes and gain a metacognitive understanding of these processes (i.e., learn to learn). A blended learning context can provide the independence and increased control essential to developing critical thinking” (p. 98). The learning opportunity provided by a blended course is robust because it transforms the communication possibilities for teacher-learner and learner-learner interactions with respect to time and place through use of the Internet (Garrison & Kanuka, 2004; Picciano, 2001; Porter, Graham, Spring, & Welch, 2014; Vaughan, 2007). It is through communication – written, verbal, in person, virtual, synchronous, or asynchronous – that higher-level learning occurs (Bransford et al., 2000; Harasim, 2011; Keegan, 2013). Methods of communicating and ways to foster communication in online environments are the subject of DE and OTL theories.

Distance Education Theories and Online Collaborative Learning

To guide the development of virtual environments and OTL instructional design, Harasim (2011) proposed a 21st century theoretical framework: online collaborative learning (OCL). A key feature of OCL that differentiates it among online DE and online computer-based training is discourse, which is written or spoken discussion and conversation among two or more people, that occurs in an online learning community (Harasim, 2011). Intersubjectivity is the concept that learning is experienced as a conversation shared between a teacher and a learner (Keegan, 2013). Based in sociology and psychology, conversation is posited as the basis of thought and knowledge, and also the catalyst for civilizational development (Harasim, 2011). Thus, much of Vygotsky's (1962) work on inner speech, social cognitive development, social constructivism, collaborative learning, and the teacher-learner relationship within the learner's zone of proximal development is reflected in Harasim's (2011) OCL theory.

Among the theories posited on DE, OCL effectively incorporates: (a) interaction theory and the concept of a learning community; (b) activity theory and independent study theory of the necessity of activity and interaction to learning; (c) connectivism theory where connections made at nodes form the web of knowledge; (d) pragmatism and design thinking where transformation results from inquiry based on specific situations; and (e) transactional distance theory through which community is built by simultaneously decreasing the *distance* (i.e., perceived virtual, emotional, social, and intellectual) and increasing the feeling of connectedness/closeness between the teacher and the learner (T. Anderson & Elloumi, 2004; Harasim, 2011; Keegan, 2013; Siemens, 2005; Simonson et al., 2000). Although these theories differ in their approaches, they share commonalties such as a learner-centered design that utilizes collaboration as the learning method and constructivism as the teaching method.

"Whether or not we consciously intend to operationalize a particular theory of learning, we are nonetheless operating according to some perspective on how to teach (and concomitantly, even if unconsciously, a perspective on how people learn." (Harasim, 2011, p. 5) Over the course of the past year with the knowledge gained through JHU EdD coursework, my methods and philosophy of teaching and learning have not changed dramatically. However, my vocabulary, core content knowledge of education theories, and dedication to my students have grown substantially. Also, I have grown to understand my problem of practice on new levels and from new perspectives, and I recognized the alignment of my teaching history with constructivist theory. I teach in a constructivist model via scaffolding, conducting experiential learning of authentic activities, facilitating problem-based and case-based learning exercises, and individualized apprenticeship (Bransford et al., 2000; Bruner, 1966; Cobb & Bowers, 1999; Ertmer & Newby, 2013; Harasim, 2011). Figures 3 and 4 are concept maps depicting my conceptualization how OCL integrates with the basic learning theories of behaviorism, congnitivism, and constructivism.

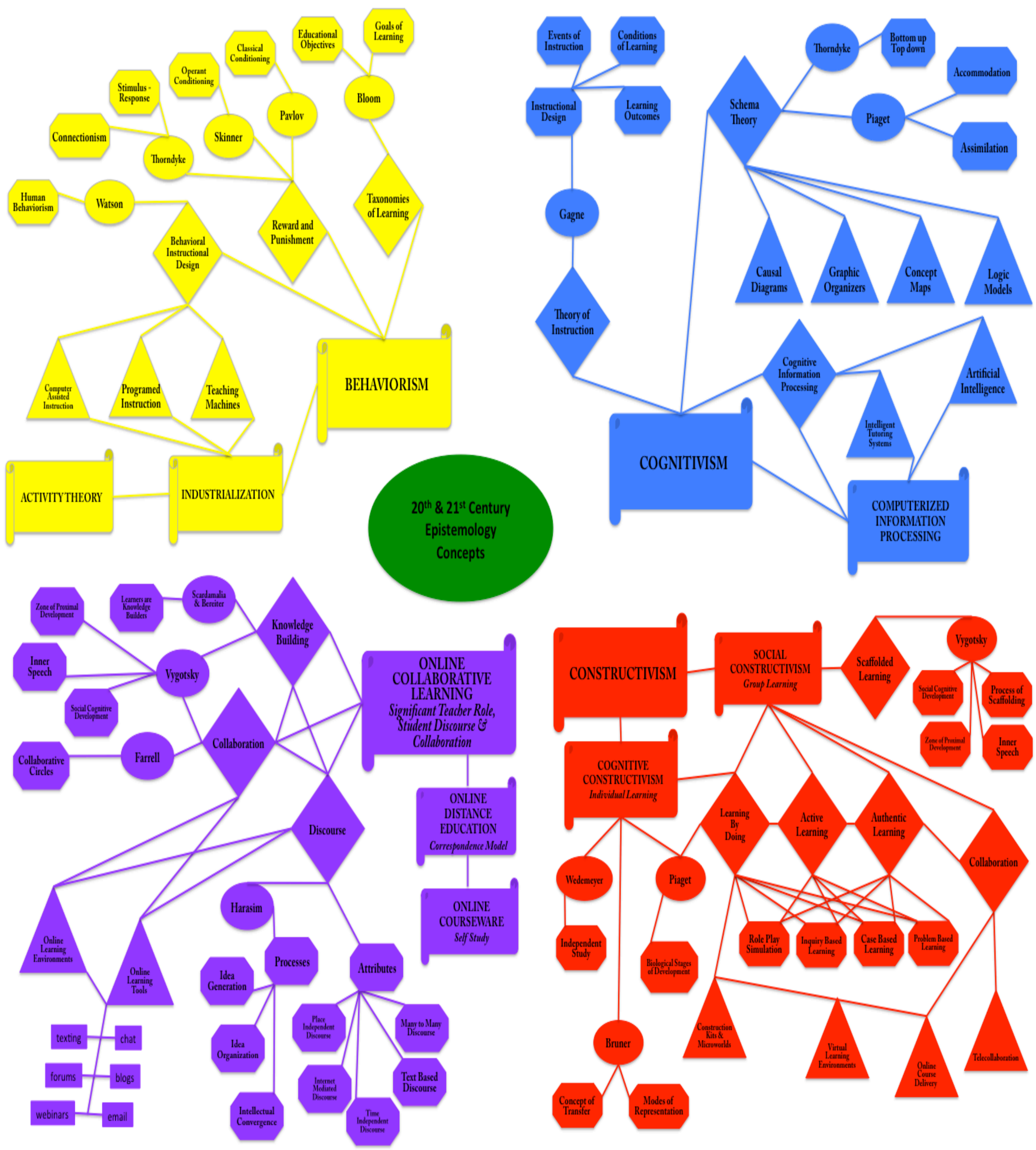


Figure 3. Concept map of 20th and 21st Century epistemology.

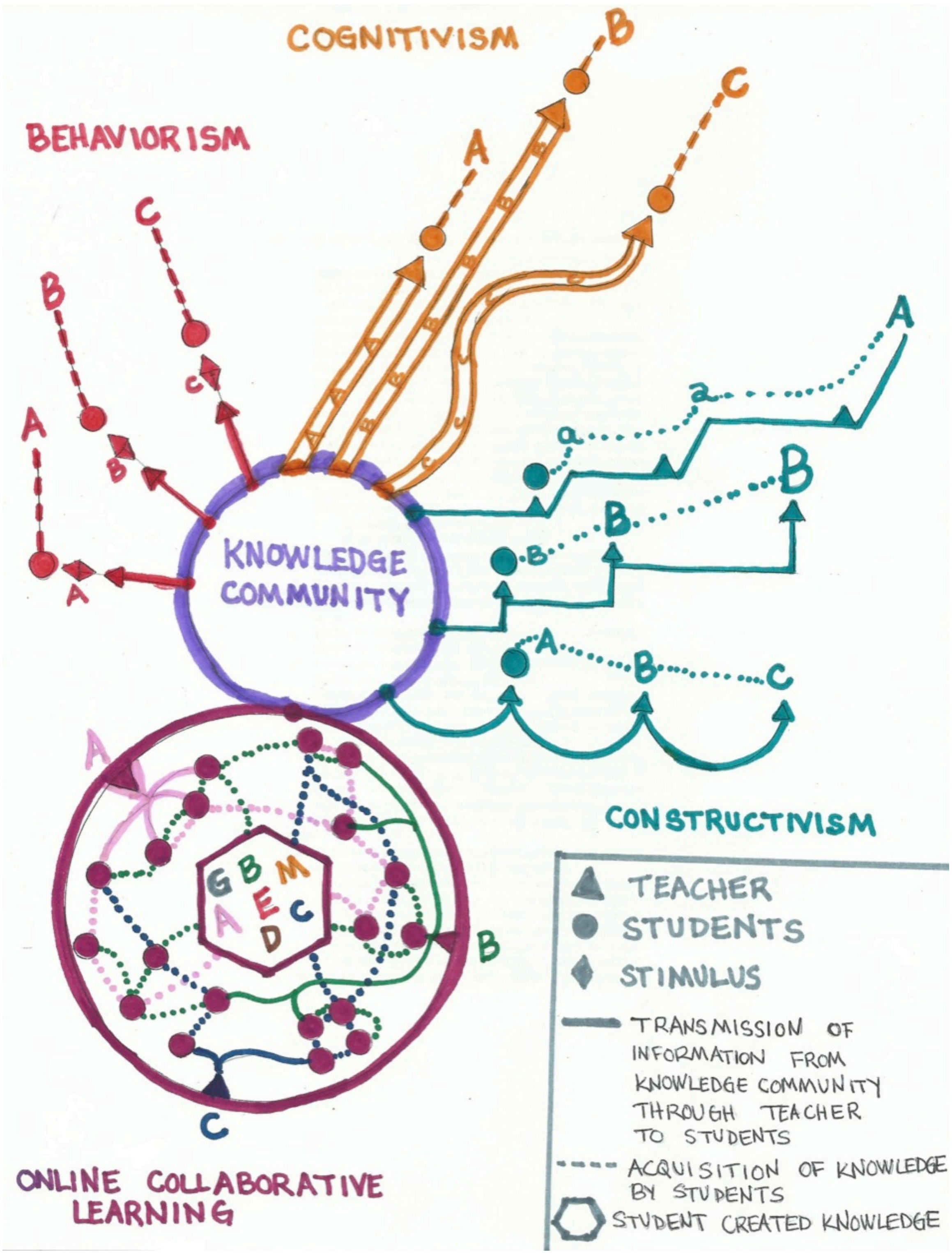


Figure 4. Concept map: Modes of transmission of information from knowledge community by teachers and knowledge acquisition by learners.

In summary, OCL provides a theoretical framework for how people learn in an online environment based on use of language and communication to engage in discourse (Harasim, 2011). Underlying and contributing to OCL, is the concept that communities "provide the condition [i.e., collaboration] for free and open dialogue, critical debate, negotiation, and agreement—the hallmark of higher education" (Garrison & Kanuka, 2004, p. 97).

Community of Inquiry: The Educational Experience

The Community of Inquiry (CoI) framework was described in the seminal article by Garrison, Anderson, and Archer (1999) as a concept which "identifies the elements that are crucial prerequisites for a successful higher educational experience" (p. 87). The three elements – social presence, cognitive presence, and teaching presence – interact to establish and maintain the processes of selecting content, setting the climate, and supporting discourse which concomitantly creates the educational experience (Garrison et al., 1999). The authors, their colleagues, and other researchers have contributed to a substantial body of literature on the CoI framework over the past 15 years (Cleveland-Innes & Campbell, 2012; Garrison, Anderson, & Archer, 2010; Rourke & Kanuka, 2009; Rubin, 2013; Shea et al., 2014; Thoms & Eryilmaz, 2014; Wang, Shannon, & Ross, 2013), and have also expanded the application of the CoI framework to designing blended courses (Garrison & Kanuka, 2004; Graham, Woodfield, & Harrison, 2013; Porter et al., 2014; Vaughan, 2007).

This literature can inform the intervention of creating a blended course at the graduate level. As course director and primary instructor, the element of teaching presence is almost exclusively under my control through the CoI recommended activities of course design and organization, facilitation of discourse, and direct instruction (Garrison et al., 1999). Similarly, the elements of social presence and cognitive presence are affected by teaching presence (Garrison et al., 1999).

New Perspective, Same BTT Lens

In this new perspective, I equate *flipped classroom* to a situational description of learning experiences where out of class time is spent doing pre-class preparation and classroom time is transformed from presentation format into applied learning exercises. As a subsequent portrayal of learning experiences, I associate *blended course* with a quantitative description of content delivered out-of-class versus in-class, a qualitative description of content delivery methods of online versus f2f, and a qualitative description of the continuity between the online and f2f learning environments.

The interactions of the three CoI presences affect content selection, the climate, and ensuing discourse (Garrison et al., 1999). Together, these relationships comprise the educational experience, and are parallel to Brain Targets One, Two, and Three (Hardiman et al., 2012). Brain Targets Four and Five recommend instructors utilize pedagogical methods that can lead to knowledge mastery, extension, and application on a deep level (Hardiman et al., 2012). The concept of *deep learning* involves cognitive processing and understanding on a high/deep level, as opposed to *surface learning*, which is associated with memorization and low cognitive load (Czerkawski, 2014). The Hewlett Foundation (2010) identified six deeper learning outcomes:

- Master core academic content.
- Think critically and solve complex problems.
- Work collaboratively.

- Communicate effectively.
- Learn how to learn.
- Develop academic mindsets.

The six abilities are similarly described by Hardiman (2012) as goals for BTT, by the American College of Graduate Medical Education (ACGME) as core competencies required of medical students and residents (Batalden, Leach, Swing, Dreyfus, & Dreyfus, 2002; Essary & Stoehr, 2009; Philibert, 2012; Swing, 2002), by anatomists and anesthesiologists aligning courses with ACGME recommendations (J. K. Gregory, Lachman, Camp, Chen, & Pawlina, 2009; Hassell, Fung, & Chaser, 2011; Rose & Burkle, 2006), and by the course director of BAHS 500 and ANES 525 at EUAAP as course objectives (Pettus & Mitchell, 2013).

This portion of the literature review provides support for my claim that the ANES 525 objectives and pedagogy are in alignment with evidence-based best practice in the fields of higher education, medical education, and online learning. I can now proceed to further investigating ID for the online component of the course redesign project.

Instructional Design Theories and Models Applied to Medical Education

To begin the discussion of instructional design theory and models, the term should first be defined. Reiser and Dempsey (2011) posed this definition:

> The field of instructional design and technology (also know as instructional technology) encompasses the analysis of learning and performance problems, and the design, development, implementation, evaluation, and management of instructional and non-instructional processes and resources intended to improve

> learning and performance in a variety of settings, particularly education institutions and the workplace. (p. 5)

This prescriptive follows the ADDIE framework as applied to instructional design (ID) activities and processes (Branch, 2010). Reiser and Dempsey (2011) list six characteristics of ID that should be ever-present: (a) learner centered; (b) goal oriented; (c) focused on meaningful performance; (d) assume outcomes can be measured in a reliable and valid way; (e) empirical, iterative, and self-correcting; and (f) typically a team effort.

The project is focused on the ID of a graduate level clinically oriented anatomy course for health professions students: ANES 525 Applied Anatomy for Anesthesia Practice, to be designed specifically for anesthesiologist assistant students at EUAAP. As such, ID for this course will incorporate best practices from medical education and take an approach to design from the perspective of adult learning theory. In my opinion, the first three ID characteristics listed by Reiser and Dempsey (2011) resonate with literature describing characteristics of adult learners and principles of adult learning theory (Crawford, Bubb, & Smith, 2011; Gilstrap, 2013; Holton, Swanson, & Naquin, 2001). Medical education at the university level is exclusively directed toward adult learners, and principles of adult learning theory are prevalent in the literature (Bernard, Balodis, Kman, Caterino, & Khandelwal, 2013; Drake, 2007; Edmunds & Brown, 2010; Kovacs, 1997; Mann, 1999, 2011; Newble & Entwistle, 1986; Pandey & Zimitat, 2007; Taylor & Hamdy, 2013; Weitzel, Walters, & Taylor, 2012).

Add to the mix a third consideration of online learning theories. ID of ANES 525 involves flipping the classroom to deliver a blended course, so although the literature in medical education on blended and online learning is new, it is supported by a breadth of research from the general higher education field (Cercone, 2008; Ellaway & Masters, 2008; Kidd & Global, 2010; Kidd & Keengwe, 2010; Lewis & Shaffer, 2010; Porter et al., 2014; Ruiz, Mintzer, & Leipzig, 2006; Shaffer, 2004; Shaffer & Small, 2004). Hence, this portion of the intervention literature review focuses on identifying empirical research and best practices in higher education and medical education for online and blended courses for adult learners that apply to specific ID and development aspects of more general ID theories, frameworks, and models so as to inform the ID of ANES 525 (see Figure 5).

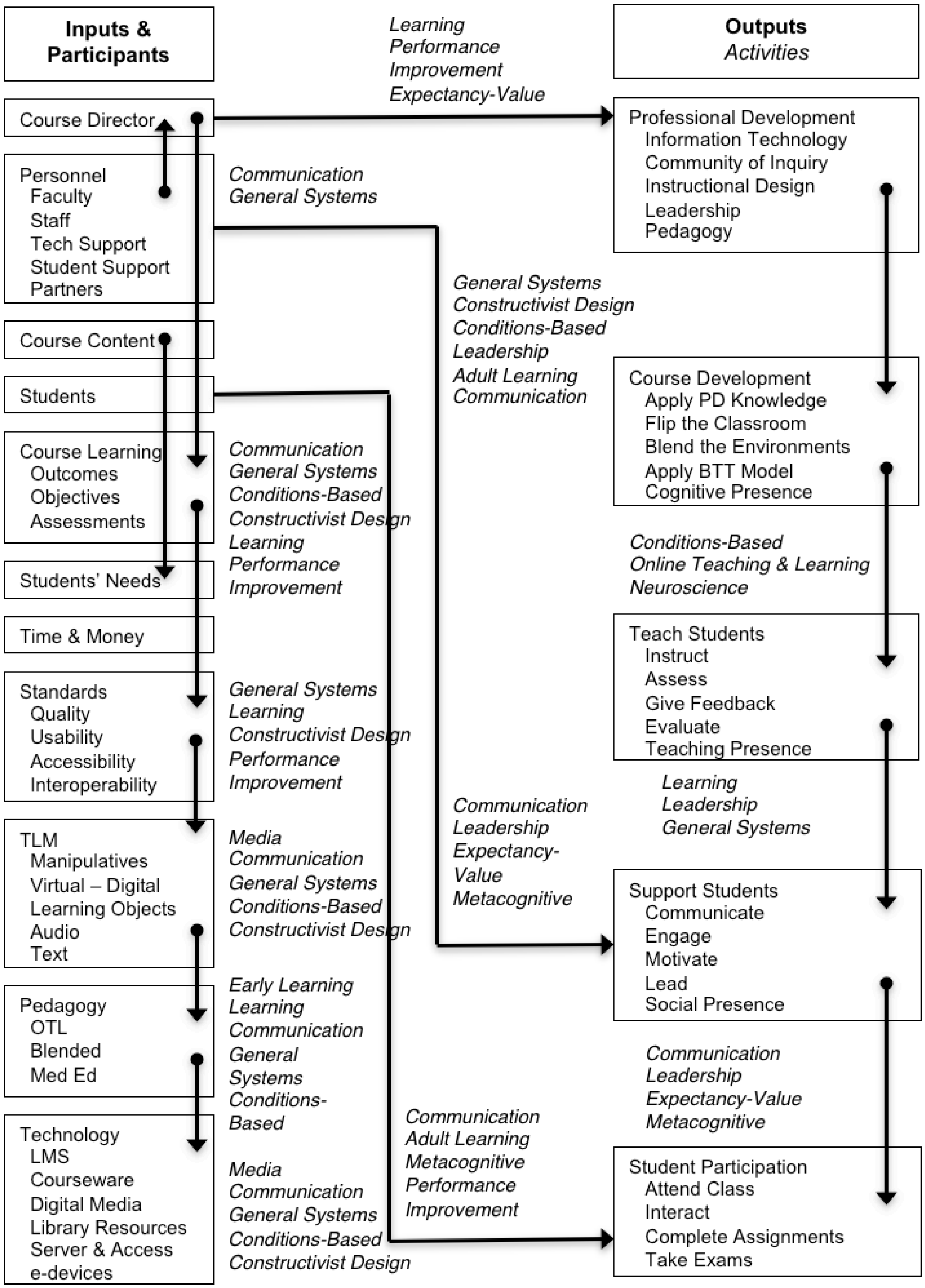


Figure 5. Theory of Treatment: Instructional design theory.

Just as the human body (systematic) is comprised of separate but integrated (systemic) organs, each one serves a unique and required purpose (responsive), but cannot function alone (interdependence) (Reiser & Dempsey, 2011). The organs communicate (cybernetic) to maintain homeostasis (dynamic), and backup systems (redundancy) safeguard against failure of the system (Reiser & Dempsey, 2011). Working together (synergistic), the organs can sustain the life (creativity) of the body and mind (Reiser & Dempsey, 2011). These nine characteristics describe the general systems approach required to facilitate the complex application of ID theories, which is framed by various ID models. General systems theories and ID models will be utilized through the ADDIE approach. ADDIE is an acronym for analyze, design, develop, implement, and evaluate (Branch, 2010). This framework is the basis for and has been adapted and transformed into numerous ID models (Reiser & Dempsey, 2011).

Analyze

Analyze can be an entire needs assessment of the problem of practice or design issue, or can be focused on specific pieces of ID process (Branch, 2010). For instance, my chosen ID model, the Dick and Carey model (Dick, Carey, & Carey, 2005) lists three activities that require analysis: (a) assess needs to identify goals; (b) conduct instructional analysis; and (c) analyze learners and contexts. AA students are adult learners in the context of medical education. Their goal is become anesthesia providers.

Analyze learners and contexts. Theory characterizes adult learners as self-directed, autonomous, collaborative, socially influenced and oriented, require relevance, problem-centered, goal oriented, intrinsically motivated, experiential learners, and active participants (Crawford et al., 2011; Snyder, 2009). Social theories of learning emphasize context of the learning environment and sense of community affect adult learners (Garrison, 2000; Garrison et al., 1999; Lave & Wenger, 1991; Rourke & Kanuka, 2009; Wenger, 2000, 2011). The Community of Inquiry (CoI) framework was described by Garrison et al. (1999) as a concept that "identifies the elements that are crucial prerequisites for a successful higher educational experience" (p. 87). The three elements – social presence, cognitive presence, and teaching presence – interact to establish and maintain the processes of selecting content, setting the climate, and supporting discourse (Garrison et al., 1999). By extrapolating the CoI framework into a Community of Practice (CoP), AA students can experience legitimate peripheral participation, collegial collaboration, inclusion, and discourse, and simultaneously develop a professional self-identity (Lave & Wenger, 1991; Wenger, 2000, 2011). I would name the CoP *The Anesthesia Lounge* because it is the break room in the perioperative area where AAs drink coffee, eat lunch, and interact as describe above. Even with minimal clinical exposure, AA students should be able to comprehend the parallel between an online CoP and the physical anesthesia lounge.

Bransford et al. (2000) described four learning environments (LE), each of which has a specific focus, or center: learner, knowledge, assessment, and community. In my opinion, my POP most closely resembles their description of a knowledge-centered LE. The instructor facilitates student development of knowledge, skills, and attitudes so that students may obtain a deep understanding of the concepts, and thereby apply and transfer the newly acquired knowledge, skills, and attitudes to subsequent courses and the clinical learning environment. Behaviorist theories, such as Bloom's taxonomy (Bloom, 1956), are ubiquitously applied in medical education (Bouchard, 2011; Krathwohl, 2002;

Phillips, Smith, & Straus, 2013). Clinical skills are taught based on checklists of behavioral objectives, student practice the skills, and are given real-time feedback and reinforcements from instructors. For instance, to collect a sample tube of blood from a patient, the clinician must have procedural knowledge of the skill and content knowledge of the anatomy. Procedural knowledge may also be acquired via a cognitivist approach, and also, through using ID to decrease cognitive load (Reiser & Dempsey, 2011). The 4C/ID model by Van Merrienboer, Kirschner, and Kester (2003) recommended complex tasks be sequenced in whole-task versions from simple to complex, and may be combined with part-task practice and just in time teaching.

The course title, Applied Anatomy for Anesthesia Practice, reflects the ID of integrated learning between classroom and clinic via inclusion of authentic activities, inclusion of clinical correlations, and utilization of PBL, legitimate peripheral participation, and cognitive apprenticeship. Thus, situated learning applies cognitivist theory to a social environment (Bransford et al., 2000; Handley, Sturdy, Fincham, & Clark, 2006). This social learning approach is carried out within a CoP (Lave & Wenger, 1991). The culture of medical education closely mimics the culture of medical practice. Students are required to wear scrubs to 'class', where the physical learning environment may be a lab practical, human-patient simulation, or clinic. Discussions frequently begin with a query of "What happened (what did you observe/do/experience) in clinical this week?" or "Has anyone done this procedure/skill in clinical?" Engaging discussions ensue, and I have come to truly appreciate the magnitude of learning that takes place during these in-class CoP conversations.

Assess needs to identify goals. The course ANES 525 Applied Anatomy for Anesthesiology aims to: (a) make the student appreciate the importance of anatomy to the practice of anesthesiology; (b) help the student acquire knowledge and skills (cognitive, psychomotor, affective, and communication) required of an anesthesia provider; and (c) develop the ability of the student to transfer acquired knowledge and skills to subsequent courses and to the clinical environment.

Conduct instructional analysis. Gagne (1984) described five categories of learning outcomes, how learning (L) of each occurs, and the effects (E) of each outcome.

- Intellectual skills (i.e., procedural knowledge) [e.g., concepts, rules, procedures, sequences of steps] L: repetition. E: completing/retrieving the correct sequence, increasing speed, and automatization. Over time, changes occur in processing, but outcomes are static.
- Verbal information (i.e., declarative knowledge) [e.g., statement, script, recitation, description] L: repetition, recall, and organization of themes. E: verbatim reinstatement and composition (recognition of themes through discourse). Over time, information is processed more deeply, concepts are formed, links are made, and retrieval is faster and more accurate (quality of outcomes increase).
- Cognitive strategies (i.e., executive control processes, strategic knowledge) [e.g., knowing when and how to use prior procedural and declarative knowledge, transfer to novel situations] L: encoding, retrieval, and problem solving. E: not well understood, nor is how to teach others to invoke these strategies.

- Motor skills (i.e., doing) [e.g., performances] L: repetition of particular muscle movements, and has three stages: (a) cognitive phase (executive subroutine) – learning of the underlying procedure; (b) associative phase – parts of the skill become fluid and whole; (c) autonomous phase (automatization) – skill is performed with decreasing attention. E: an improvement in the quality of movement.
- Attitudes (i.e., inferred internal states from observed behaviors with cognitive and emotional components, influencers and modifiers, but not determinants of behaviors) [e.g., fairness, avoidance, rejection, acceptance]. L: human model exhibits behavior of personal choice, learner observes, reinforcement to model, leaner observes (vicarious reinforcement), learner encodes/adopts model's behavior (Bandura, 1986). E: persistent even without reinforcement or repetition, highly resistant to change.

In general terms, student learning is the focal outcome of this ID project. My tasks are to categorize types of expected ANES 525 learning outcomes, and subsequently, use that to inform determination of entry behaviors, construction of performance objectives, and development of assessments throughout the process of ID.

Design

Following the Dick and Carey model, this step is to write performance objectives aligned to the learning goals and expected learning outcomes (Dick et al., 2005). That is, to list and describe what the learners should know and be able to do at the conclusion of instruction. In medical education as well as medical practice, motor and intellectual clinical skills possess established, desired outcomes (Dangerfield, Bradley, & Gibbs, 2000; Kovacs, 1997; Reznick, 1993; Reznick, Regehr, MacRae, Martin, & McCulloch, 1997). As an example of ways in which the intellectual clinical skill performance objectives could be addressed, the literature revealed a seminal study. Phillips et al. (2013) applied a revision of Bloom's taxonomy (L. W. Anderson, 2005; Krathwohl, 2002) to a medical school anatomy course. Specifically, they incorporated the instructional media of medical imaging as utilized within the specialty of radiology as an instructional strategy for teaching and assessing anatomy (Phillips et al., 2013). The study evaluated the reliability and validity of the assessment tool with respect to the six levels of cognitive processes it was designed to assess (Phillips et al., 2013). The assessment tool exhibited an inverse correlation between level of cognitive process and scores means, which supported the validity of a hierarchical examination question structure (Phillips et al., 2013). The tool (and its precursor tool, an examination question writing guide) were used for each learning unit, and found to be reliable (Phillips et al., 2013).

Bloom's six categories (remember, understanding, apply, analyze, evaluate, create) were labeled with cognitive processing domains (procedural knowledge and strategic knowledge), and a radiological anatomy example item/question was given (Phillips et al., 2013). A table, the accompanying description of "a formal taxonomy of medical imaging interpretation" (p. 785), and detailed curriculum ID (including objectives, instructional methods, instructional media, and assessments) will inform ID of the radiological anatomy portion of ANES 525 (Phillips et al., 2013).

Bloom's taxonomy of cognitive domain task objectives and the contemporary revisions by L. W. Anderson (2005) and Krathwohl (2002) have spurred the recent paradigm shift in medical education pedagogy (Barrows, 1986; Rose & Burkle, 2006).

The transition in setting expectations for students' outcomes at the bottom of the pyramid, such as basic knowledge acquisition, toward higher levels of learning at the top of the pyramid, such as problem-solving, aims to foster higher-order critical thinking skills and lifelong learning (Prober & Khan, 2013).

Although Kovac's (1997) article predates the aforementioned revision and transition, his description of theories, models, and methods for medical education are solid and applicable to current practice. Understanding students' ZPD's and teaching within these domains are essential to an effective competency-based curriculum (Bierer, Dannefer, Taylor, Hall, & Hull, 2008). This resonates with the instructor's social presence within the CoI (Garrison et al., 1999) and CoP (Wenger, 2011).

The affective domain can be represented by professionalism, communication skills, inter-disciplinary collaboration, teamwork, ethics, and compassion (Kovacs, 1997). Again, this resonates with the instructor's social presence, and with the students engagement with peers (Garrison et al., 1999).

The psychomotor domain can be represented by procedural skills, and is operationalized as cognitive and motor activities necessary to perform a manual task (Kovacs, 1997). Kovacs (1997) described the term *knowledge of results* as useful, sensory feedback, and noted that it is "required to learn, correct, and improve the performance of a motor action" (p. 389). Kovacs (1997) recommended novices be given timely feedback from experienced observers, thus increasing the value and effectiveness of a learner's knowledge of results above that which could be obtained via self-assessment.

Develop

Dick et al. (2005) list three ID items to develop: assessment instruments, instructional strategy, and instructional materials. To design ANES 525 and apply anatomy to anesthesiology, clinical tasks (procedural skills) can serve as effective learning tools, methods, and materials within the psychomotor domain (Sullivan et al., 2008). Additionally, practicing these clinical tasks, which are authentic activities, will be a primary source of motivation for students as they progress through the cognitive domain. This speaks to efficacy-value theory (Eccles & Wigfield, 2002) demonstrations of competency (Swing, 2002; Tetzlaff, 2009; Thomas, 2013), learner centered, goal oriented, and focused on meaningful performance intended by proper ID and desired by adult learners (Crawford et al., 2011).

Assessment instruments. It follows that observational assessments via checklists and demonstration of skills is in alignment with the learning activities (Reznick et al., 1997; Thomas, 2013). AA instructors are experienced observers and apprenticeship mentors, so PD of teaching faculty is a nonissue for implementation of this piece of the intervention. AA students are accustomed to being observed, critiqued, and functioning as apprentices, so compliance of learners is a nonissue for implementation of this piece of the intervention. I would expect the students to report a high degree of satisfaction on a statement like, "Practicing clinical skills in anatomy class helped me to learn anatomy and apply it to anesthesiology." Given the added degree of difficulty secondary to a high time commitment to collecting this type of data, a test of cognitive function will be used for efficacy and to provide statistically testable data for the quantitative portion of this research study.

Therefore, the performance objectives for a radiology module for ANES 525 are: At the end of each radiological anatomy learning module, the learners should be able to (a) apply content knowledge to medical images, (c) interpret medical images with normal and pathologic anatomy, (d) communicate findings to colleagues, (e) apply these cognitive skills within the context of clinical procedures, (f) appreciate the relevance of anatomy and medical images to the practice of anesthesiology, and (g) transfer and apply these cognitive skills to performance of clinical procedures. Adult learning theory highlights not only authentic activities for learning, but also authentic assessments (Bierer et al., 2008; Rencic, 2011; Taylor & Hamdy, 2013), and so does medical education literature (Phillips, Smith, Ross, & Straus, 2012; Reznick et al., 1997; Thomas, 2013).

Constructivist ID strategies compel utilization of different assessments than those for cognitive ID, and both are relevant to my POP lesson plan. Furthermore, ANES 525 is a letter grade course. Summative learner-centered assessments via criterion-referenced examinations is important to evaluate student progress/achievement, promote learner self-reflection, and provide evaluation of instructional quality (Dick et al., 2005). In my opinion, this is most easily accomplished via objective assessments traditional to anatomy courses, such as multiple-choice, short answer, matching, filling in blanks, and labeling. Creating authentic, constructivist assessments, such as written case reports/reflections, case presentations, literature reviews, and written anesthetic care plans, are not so difficult, but rather the grading of these subjective assessments takes more time and effort (Burns, 2010; Phillips et al., 2013). Creative projects, like informative videos, tutorials, and manipulatives/models fall on the extremely subjective end of the summative grading spectrum, but simultaneously allow the inclusion of art, inspiration, choice, and self-expression for students (E. Gregory et al., 2013; Hardiman, 2012; L. Rinne et al., 2011).

All of these objectives will be tested on written examination using computer-based testing (CBT), which allows the opportunity to present digital images as test items. EUAAP uses CBT for all such examinations, and so the students will be familiarized with CBT during the first summer semester prior to taking ANES 525 in the fall semester. Also, the students will engage with multiple formats of digital media as learning resources. Therefore, the format and media of the CBT exam aligns with intervention literature recommendations that IDers and instructors utilize similar instructional and assessment resources (Ellaway & Masters, 2008; Prégent, 2000).

Instructional strategies. Instructional strategy is a prescription used for developing or choosing instructional media and instructional methods to facilitate student mastery of learning objectives (Dick et al., 2005; Richey, Klein, & Tracey, 2011). Instructional designers should consider learners' needs, interests, and experiences, and focus on how to engage and maintain learners' attention (Dick et al., 2005; Keller, 1987). Advancement of instructional strategy frameworks grew out of Gagné's (1984) nine events of instruction, which were modified by Dick, Carey, and Carey (2005) into five learning components intended to guide learners' cognitive development via activities (*cross-referenced with IDTM course-specific terminology*):

1. Pre-instructional Activities (*Strategies for Objectives*)
    a. Motivate
    b. Describe objectives
    c. Activate prior knowledge and skills

2. Content Presentation
    a. Content (*Instructional Media; TLM*)
    b. Learning guidance (*Instructional Activities; Methods*)
3. Learner Interactions (*Learner Participation with Feedback*)
    a. Participation
    b. Feedback
4. Assessment (*Assessment Strategy*)
5. Follow-through activities

Following the Dick and Carey (2005) model of instructional design, attention was given to blending this cognitive ID model with a constructivist learning environment (CLE) to devise instructional strategies for learning to solve ill-defined problems (Dick et al., 2005). Although many of the learning objectives and activities for the project lesson plan require only lower order cognitive or verbal skills, the clinically relevant higher order skills are, in the real world, situated in complex, abstract clinical scenarios lacking single or concrete answers (Bierer et al., 2008; Burns, 2010; Krathwohl, 2002; Phillips et al., 2013). PBL has been heavily researched in higher education, medical education, in the classroom, and in virtual classrooms online (Azer, 2011; Barrows, 1986; Crawford et al., 2011; Ellaway & Masters, 2008; Thurley & Dennick, 2008). A similar, key element in the learner activities category is what I have termed SCALEs: student centered applied learning exercises, which are representative of authentic activities performed by anesthesia practitioners. Some of the SCALEs could also be used as assessments.

Identification of authentic activities. Given the POP objective of designing a clinically applied anatomy course and the resources available, I am able to provide the student with authentic learning activities in authentic environments. Students must construct and apply anatomy knowledge so as to: (a) read, write, and speak medical terminology; (b) interpret medical images; (c) assess clinical presentation of a patient; (d) assimilate data from a, b, and c to create an anesthetic care plan for each patient; (e) communicate data and care plans to patients and fellow clinicians; and (f) physically perform clinical interventions/skills/tasks necessary to carry out the care plan.

To inform ID of these learning activities, best practices from medical education literature highlighted the importance of interpretation of medical images. The diagnostic gold standard for many medical conditions is digital medical imaging studies, such as x-ray, computed tomography (CT), magnetic resonance imaging (MRI), and ultrasonography (Brenton et al., 2007; Jastrow & Vollrath, 2002, 2003; Shaffer, 2004). Additionally, these imaging techniques have been the new gold standard for many medical procedures because they provide clinicians with (a) a means to assess the patient's baseline medical condition and anatomy, (b) real-time guidance and feedback while performing a procedure, (c) confirmation and documentation for successful procedures, and (d) explanation and documentation for difficult and unsuccessful procedures (Kovacs, 1997; Phillips et al., 2013; Shaffer, 2004). One specific example in anesthesiology is the recommendation by the American Society of Anesthesiologists Task Force on Central Venous Access that ultrasonography be used to assess, guide, and confirm central venous catheter insertion (Rupp et al., 2012).

In order to interpret medical images clinicians must possess a fundamental knowledge base of anatomy, and specifically, cross-sectional anatomy (Brenton et al., 2007; Jastrow & Vollrath, 2002, 2003; Kovacs, 1997; Phillips et al., 2013; Shaffer, 2004). That knowledge is subsequently applied to various medical imaging modalities. Ultrasound-guided central venous catheter insertion also requires clinicians to possess (a) contextual knowledge of the task, (b) procedural knowledge of the task, (c) operation of the technology/machine (Brenton et al., 2007; Jastrow & Vollrath, 2002, 2003; Kovacs, 1997; Phillips et al., 2013; Shaffer, 2004).

RadLabs. Shaffer and Small (2004) emphasized the crisis in medical education as it pertains to anatomy teaching faculty: Anatomy departments are disbanding, fewer graduate students train in anatomy departments, medical schools demand clinically relevant anatomic education, clinicians lack education background, and shortened course duration. Reliance on technology to facilitate teaching via computer-assisted learning, reusable learning objects, and hosted on an LMS resulted in the creation of learning modules for radiology laboratory named RadLabs (Phillips et al., 2012). The pedagogy was based on blended learning theory, adult learning theory, and medical education teaching models. The RadLab modules were modified and redesigned in response to feedback from faculty, clinicians, and students.

Each RadLab was based on a clinical case, which established relevance and motivation for learning (Bonk & Khoo, 2014). Students were introduced to the case online, posed questions, provided explanatory material, and guided through various medical images and movies. In class/lab, students worked in small groups on PBL exercises with radiologists and anatomists. PBL is an example of constructivist learning theory teaching method, inclusion of clinical teaching faculty is a means of cognitive apprenticeship, and viewing case-based authentic patient medical images brings relevance and authenticity to the learning activities (Bonk & Khoo, 2014; Reiser & Dempsey, 2011; Richey et al., 2011).

Radiologic anatomy modules. To take the research further, Phillips et al. (2012) sought to quantify the effects of SDL via CAL of radiologic anatomy modules on learning outcomes as measured by scores on radiology, gross, and written examination. Students served as their own controls: 21 completed no SDL modules; 22 completed all six modules; and 50 completed between one and five modules (Phillips et al., 2012). The data showed significantly higher exam scores for students who completed the corresponding SDL module (Phillips et al., 2012).

The modules were based on clinical cases, included authentic patient medical images, and the application and relevance of anatomy to clinical practice was made evident (Bonk & Khoo, 2014; Reiser & Dempsey, 2011; Richey et al., 2011). The authors suggest that SDL of medical images filled a learning need not otherwise met by traditional cadaver lab instruction, and that radiology modules provided enhanced reasoning, visualization, comprehension, and recall necessary for interpreting radiographic images, gross structures, and written exam questions (Phillips et al., 2012). This evidence is especially relevant to my POP because cadaver lab will be eliminated from the TLM list, and this research shows radiographic images can partially fill the gap.

In response to these clinical practice education issues, the Alliance of Medial Student Educators in Radiology proposed a radiology curriculum for United States medical schools (Lewis & Shaffer, 2010). Phillips et al. (2013) listed radiological anatomy examples for their newly devised formal taxonomy of medical imaging interpretation, which they linked to cognitive processes within Bloom's Taxonomy of

Educational Objectives categories as revised by L. W. Anderson (2005). Phillips et al. (2013) delineated the revised taxonomy to guide ID of the anatomy curriculum including assessments, learning objectives, instructional methods and TLM. I will utilize these resources to develop a similar learning module for my anatomy course.

Implement

During the implementation of the instruction phase of ID, the IDer readies the learning environment (in-class and/or online), and prepares instructors and students to engage in the course (Baker et al., 2013; Dick et al., 2005; Reiser & Dempsey, 2011). From a design perspective, the IDer may collect data for a formative assessment of the implementation of instruction so as to make informed decisions about the subsequent iterations of the course (Baker et al., 2013; Dick et al., 2005; Reiser & Dempsey, 2011). The course is turned over to the instructor, and the IDer functions in a support role by supplying course documents, training the instructor and the students on use of the LMS, and providing explanations on points of ambiguity (Baker et al., 2013; Dick et al., 2005; Reiser & Dempsey, 2011). The instructional strategy and implementation plan is outlined for each of the six radiological anatomy learning/performance objectives in Tables 11 through 16: ANES 525 Instructional Strategies and Components for Objectives 1 through 6 of a Lesson Plan for Cross-Sectional and Radiologic Anatomy Unit.

Table 11

Objective 1: After studying cross-sectional and radiologic anatomy, the student should be able to remember usages and characteristics of digital cadaveric images, artistic renderings, and medical images depicting normal anatomy.

Learning Components	Considerations for Each Component	Instructional Strategy for Objective 1
Strategies for Objectives	Provide for motivation	Instructor shows photos, medical images, radiology reports, and anesthetic care plans from actual patient cases. A*uthenticity.*
	Relevance	Invites learners to recall and share relevant clinical experiences. *Personalization.*
	Confidence	In order to interpret medical images clinicians must possess a fundamental knowledge base of anatomy, and specifically, cross-sectional anatomy. Your ability to interpret medical images will result in safer patient care.
	Inform learners of objectives	1.1 Recognize, identify, and name anatomic structures. 1.2 Recognize, identify, and name imaging modalities. 1.3 List common diagnostic examinations that utilize medical imaging. 1.4 List common anesthetic procedures that utilize medical imaging.
	Promote recall of prerequisites	Remind learners of medical terminology and basic anatomical structures.
	Link new content to existing knowledge/skills	Remind learners of physiology, pharmacology, and anesthesiology from the previous semester. Parallel real-time medical imaging to video games.
Instructional Activities	Sequence based on hierarchy of skills	1.1 through 1.4 in order.
	Explain characteristics of concepts	Structural anatomic relationships, 2D images, 3D images, mental schema of spatial relationships, anatomical planes, imaging planes, image type, imaging studies, anesthetic procedures.

Learning Components	Considerations for Each Component	Instructional Strategy for Objective 1
	Provide examples and non-examples	Demonstrate correct and incorrect orientation of images.
	Create ways of organizing new into existing skills	Show labeled cross-sectional anatomy and corresponding medical images. *Matching*
Learner Participation	Correlate practice with patient care; utilize authentic activities	Show medical images and have learners perform 1.1 through 1.4 via self-directed learning modules online, online discussion groups, and peer learning groups in class.
	Progress from easy to difficult	Labeled cross-sectional diagrams, cadaver images, and medical images.
	Use simulations for practice in an authentic learning environment; promote transfer	Unlabeled cross-sectional diagrams, cadaver images, and medical images. SCALE: Have learners use an ultrasound machine to view and identify structures on each other.
	Give formative feedback	For incorrect labeling and orientating, show ways to identify mystery structures by process of elimination and spatial relationships to surrounding structures.
Instructional Media	LMS online TLM	The Virtual Human Dissector Anatomy textbook (TBD) Medical imaging textbook (TBD) Netter Atlas Introductory PPT/presentation YouTube videos Assigned readings (textbooks and medical literature) Links to adjunct and advanced readings
	Classroom/lab	All the above plus: anatomic specimens, models, ultrasound machine, simulation manikins, living anatomy
Assessment Strategy	Accommodate hierarchical nature of skills	Bloom's level 1: remember – factual Test items: label, list, name, identify; MCQs; matching. Incorporate IM used for assignments.

Table 12

Objective 2: After studying cross-sectional and radiologic anatomy, the student should be able to interpret medical images depicting normal and abnormal anatomy.

Learning Components	Considerations for Each Component	Instructional Strategy for Objective 2
Strategies for Objectives	Provide for motivation	Instructor shows photos, medical images, radiology reports, and anesthetic care plans from actual patient cases. Authenticity Invites learners to recall and share relevant clinical experiences. Personalization
	Relevance	The diagnostic gold standard for many medical conditions is medical imaging studies. In order to interpret medical images clinicians must possess a fundamental knowledge base of anatomy, and specifically, cross-sectional anatomy.
	Confidence	Your ability to interpret medical images will result in safer patient care.
	Inform learners of objectives	2.1 Describe anatomic relationships among structures. 2.2 Describe characteristics of each imaging modality. 2.3 Classify structures as normal or abnormal. 2.4 Describe the abnormality.
	Promote recall of prerequisites	Remind learners of medical terminology and basic anatomical structures.
	Link new content to existing knowledge/skills.	Remind learners of physiology, pharmacology, and anesthesiology from the previous semester. Remind learners of previous objectives.
Instructional Activities	Sequence based on hierarchy of skills	2.1 through 2.4 in order.
	Explain characteristics of concepts	Structural anatomic relationships, 2D images, 3D images, mental schema of spatial relationships, anatomical planes, imaging planes, image type, imaging studies, normal and abnormal anatomy.
	Provide examples and non-examples	Demonstrate correct and incorrect identification of normal and abnormal structures.

Learning Components	Considerations for Each Component	Instructional Strategy for Objective 2
	Create ways of organizing new into existing skills	Show normal cross-sectional anatomy and corresponding medical images. Show abnormal medical images.
Learner Participation	Correlate practice with patient care; utilize authentic activities	Show medical images and have learners perform 2.1 through 2.4 via self-directed learning modules online, online discussion groups, and peer learning groups in class.
	Progress from easy to difficult	Normal, unlabeled cross-sectional diagrams, cadaver images, and medical images. Abnormal, unlabeled cross-sectional diagrams, cadaver images, and medical images.
	Use simulations for practice in an authentic learning environment; promote transfer	SCALE: Have learners classify images as normal or abnormal. Describe the abnormality in medical terms as if giving report to a colleague.
	Give formative feedback	For incorrect classification, show ways to identify mystery structures by process of elimination and spatial relationships to surrounding structures.
Instructional Media	LMS online TLM	The Virtual Human Dissector Anatomy textbook (TBD) Medical imaging textbook (TBD) Netter Atlas Introductory PPT/presentation YouTube videos Assigned readings (textbooks and medical literature) Links to adjunct and advanced readings
	Classroom/lab	All the above plus: anatomic specimens, models, ultrasound machine, simulation manikins, living anatomy
Assessment Strategy	Accommodate hierarchical nature of skills	Bloom's level 2: understand – factual, conceptual Test items: label, list, name, identify, classify, describe; MCQs; matching, filling blanks, short answer. Incorporate IM used for assignments.

Table 13

Objective 3: After studying cross-sectional and radiologic anatomy, the student should be able to apply medical imaging to anesthesiology practice.

Learning Components	Considerations for Each Component	Instructional Strategy for Objective 3
Strategies for Objectives	Provide for motivation	Instructor shows photos, medical images, radiology reports, and anesthetic care plans from actual patient cases. *Authenticity* Invites learners to recall and share relevant clinical experiences. *Personalization*
	Relevance	The diagnostic gold standard for many medical conditions is medical imaging studies. Clinicians must decide which imaging study to order to obtain the necessary information to determined the course of treatment. In order to make clinical decisions, clinicians must possess a fundamental knowledge base of anatomy, and specifically, cross-sectional anatomy.
	Confidence	Your ability to interpret medical images will result in safer patient care.
	Inform learners of objectives	3.1. Arrange medical images sequentially within each of the three anatomic planes. 3.2 Choose the best imaging modality for a given diagnostic examination. 3.3 Choose the best anatomic plane to view for a given diagnostic examination. 3.4 Choose the best imaging modality for a given clinical procedure. 3.5 Choose the best anatomic plane to view for a given clinical procedure.
	Promote recall of prerequisites	Remind learners of medical terminology and basic anatomical structures.
	Link new content to existing knowledge/skills.	Remind learners of physiology, pharmacology, and anesthesiology from the previous semester. Remind learners of previous objectives.
Instructional Activities	Sequence based on hierarchy of skills	3.1 through 3.5 in order.

Learning Components	Considerations for Each Component	Instructional Strategy for Objective 3
	Explain characteristics of concepts	Structural anatomic relationships, mental schema of spatial relationships, anatomical planes, imaging planes, diagnostic imaging studies, clinical procedures, normal and abnormal anatomy, patient presentation.
	Provide examples and non-examples	Demonstrate correct and incorrect choices of diagnostic imaging studies given a different imaging modalities and clinical procedures.
	Create ways of organizing new into existing skills	Show normal cross-sectional anatomy and corresponding medical images. Show abnormal medical images.
Learner Participation	Correlate practice with patient care; utilize authentic activities	Show medical images and have learners perform 3.1 through 3.5 via SDL modules online, online discussion groups, and peer learning groups in class.
	Progress from easy to difficult	Lists of imaging modalities, diagnostic imaging studies, and clinical procedures from simple to complex patient chief complaint presentation.
	Use simulations for practice in an authentic learning environment; promote transfer	SCALE: Have learners choose imaging modalities as appropriate for various diagnostic imaging studies and clinical procedures from simple to complex. Describe the clinical decision making process in medical terms to a colleague.
	Give formative feedback	For incorrect choices, show ways common applications of imaging modalities for specific diagnostic imaging studies and clinical procedures.
Instructional Media	LMS online TLM	The Virtual Human Dissector Anatomy textbook (TBD) Medical imaging textbook (TBD) Netter Atlas Introductory PPT/presentation YouTube videos Assigned readings (textbooks and medical literature) Links to adjunct and advanced readings
	Classroom/lab	All the above plus: anatomic specimens, models, ultrasound machine, simulation manikins, living anatomy

Learning Components	Considerations for Each Component	Instructional Strategy for Objective 3
Assessment Strategy	Accommodate hierarchical nature of skills	Bloom's level 3: apply – factual, conceptual, procedural Test items: label, list, name, identify, classify, describe, choose; MCQs; matching, filling blanks, short answer; sequencing. Incorporate IM used for assignments.

Table 14

Objective 4: After studying cross-sectional and radiologic anatomy, the student should be able to <u>*analyze*</u> *medical images and radiology reports.*

Learning Components	Considerations for Each Component	Instructional Strategy for Objective 4
Strategies for Objectives	Provide for motivation	Instructor shows photos, medical images, radiology reports, and anesthetic care plans from actual patient cases. *Authenticity* Invites learners to recall and share relevant clinical experiences. *Personalization*
	Relevance	These imaging techniques are the new gold standards for many medical procedures because they provide clinicians with a means to assess the patient's baseline medical condition and anatomy, real-time guidance and feedback while performing a procedure, confirmation and documentation for successful procedures, and explanation and documentation for difficult and unsuccessful procedures.
	Confidence	Your ability to interpret medical images will result in safer patient care.
	Inform learners of objectives	4.1 Differentiate between normal and abnormal structures. 4.2 Deduce which medical image corresponds to a given radiology report. 4.3 Attribute possible/probable causes of abnormal structures. 4.4 Attribute possible/probable effects of abnormal structures.
	Promote recall of prerequisites	Remind learners of medical terminology and basic anatomical structures.

Learning Components	Considerations for Each Component	Instructional Strategy for Objective 4
	Link new content to existing knowledge/skills.	Remind learners of physiology, pharmacology, and anesthesiology from the previous semester. Remind learners of previous objectives.
Instructional Activities	Sequence based on hierarchy of skills	4.1 through 4.4 in order.
	Explain characteristics of concepts	Structural anatomic relationships, 2D images, 3D images, mental schema of spatial relationships, anatomical planes, imaging planes, image type, imaging studies, normal and abnormal anatomy.
	Provide examples and non-examples	Demonstrate correct and incorrect identification of normal and abnormal structures. Analyze probable/possible causes and effects of abnormalities.
	Create ways of organizing new into existing skills	Show normal cross-sectional anatomy and corresponding medical images. Show abnormal medical images. Provide written radiology reports and corresponding images.
Learner Participation	Correlate practice with patient care; utilize authentic activities	Show medical images and have learners perform 4.1 through 4.4 via SDL modules online, online discussion groups, and peer learning groups in class.
	Progress from easy to difficult	Normal, unlabeled cross-sectional diagrams, cadaver images, and medical images. Abnormal, unlabeled cross-sectional diagrams, cadaver images, and medical images.
	Use simulations for practice in an authentic learning environment; promote transfer	SCALE: Have learners classify images as normal or abnormal. Describe the abnormality in medical terms as if giving report to a colleague. Deduce which medical image corresponds to a given radiology report. Discuss probable causes and effects of the abnormality.
	Give formative feedback	For incorrect classification, show ways to identify structures and medical terminology by process of elimination and spatial relationships to surrounding structures.

Learning Components	Considerations for Each Component	Instructional Strategy for Objective 4
Instructional Media	LMS online TLM	The Virtual Human Dissector Anatomy textbook (TBD) Medical imaging textbook (TBD) Netter Atlas Introductory PPT/presentation YouTube videos Assigned readings (textbooks and medical literature) Links to adjunct and advanced readings
	Classroom/lab	All the above plus: anatomic specimens, models, ultrasound machine, simulation manikins, living anatomy.
Assessment Strategy	Accommodate hierarchical nature of skills	Bloom's level 4: analyze – factual, conceptual, procedural, metacognitive Test items: label, list, name, identify, classify, describe; deduce, analyze; MCQs; matching, filling blanks, short answer, essay. Incorporate IM used for assignments.

Table 15

Objective 5: After studying cross-sectional and radiologic anatomy, the student should be able to <u>*evaluate*</u> *imaging findings as pertains to anesthetic implications and anesthetic care plans.*

Learning Components	Considerations for Each Component	Instructional Strategy for Objective 5
Strategies for Objectives	Provide for motivation	Instructor shows photos, medical images, radiology reports, and anesthetic care plans from actual patient cases. *Authenticity* Invites learners to recall and share relevant clinical experiences. *Personalization*

Learning Components	Considerations for Each Component	Instructional Strategy for Objective 5
	Relevance	Students must construct and apply anatomy knowledge so as to progress along the professional continuum from novice toward expert anesthesia provider by learning to: read/write/speak medical terminology; interpret medical images; assess clinical presentation of a patient; assimilate data to create a care plan for each patient; communicate data and care plans to patients and fellow clinicians; and physically perform clinical interventions/skills/tasks necessary to carry out the care plan.
	Confidence	Your ability to critique an anesthetic care plan and discuss the plan with colleagues will result in safer patient care.
	Inform learners of objectives	5.1 Discuss perioperative and anesthetic implications of identified causes of abnormal structures. 5.2 Discuss perioperative and anesthetic implications of identified effects of abnormal structures. 5.3 Critique a written anesthetic care plan for a given patient (H & P, medical image, and radiology report). 5.4 Arrange suggested components of an anesthetic care plan (i.e., Plan A, B, C . . . G) in to a best-practice sequence for a given patient with an H & P, medical image, and radiology report. 5.5 Write a Case Reflection that identifies a gap in application of anatomy to anesthesiology. Discuss implications for patient care. Suggest ways to improve your practice.
	Promote recall of prerequisites	Remind learners of medical terminology and basic anatomical structures.
	Link new content to existing knowledge/skills.	Remind learners of physiology, pharmacology, and anesthesiology from the previous semester. Remind learners of previous objectives.
Instructional Activities	Sequence based on hierarchy of skills	5.1 through 5.5 in order.
	Explain characteristics of concepts	Perioperative and anesthetic implications of abnormal anatomy and imaging studies, anesthetic are plan components, Case Reflection for PI.

Learning Components	Considerations for Each Component	Instructional Strategy for Objective 5
	Provide examples and non-examples	Discuss perioperative and anesthetic implications of abnormal structures. Demonstrate formation of an anesthetic plan via case study. Demonstrate a case reflection for PI and LLL.
	Create ways of organizing new into existing skills	Show abnormal medical images. Provide H&P, written radiology reports, and corresponding medical images.
Learner Participation	Correlate practice with patient care; utilize authentic activities	Show medical images, H&P, radiology reports, and have learners perform 5.1 through 5.5 via SDL modules online, online discussion groups, and peer learning groups in class.
	Progress from easy to difficult	Abnormal, unlabeled cross-sectional diagrams, cadaver images, and medical images. Abnormal radiology reports and H&P. Present case studies of increasing complexity.
	Use simulations for practice in an authentic learning environment; promote transfer	SCALE: Describe the abnormality in medical terms as if giving report to a colleague. Discuss probable causes and effects of the abnormality. Discuss perioperative and anesthetic implications of abnormal structures. Critique an anesthetic plan. Arrange components of an anesthetic plan.
	Give formative feedback	For incorrect critiques and plans, show clinical reasoning steps explicitly. Provide a plan-making checklist.
Instructional Media	LMS online TLM	The Virtual Human Dissector Anatomy textbook (TBD) Medical imaging textbook (TBD) Netter Atlas Introductory PPT/presentation YouTube videos Assigned readings (textbooks and medical literature) Links to adjunct and advanced readings
	Classroom/lab	All the above plus: anatomic specimens, models, ultrasound machine, simulation manikins, living anatomy.
Assessment Strategy	Accommodate hierarchical nature of skills	Bloom’s level 5: evaluate – factual, conceptual, procedural, metacognitive Test items: identify, classify, describe, deduce, analyze, critique, arrange; evaluate; MCQs, short answer, essay.

Table 16

Objective 6: After studying cross-sectional and radiologic anatomy, the student should be able to create anesthetic care plans.

Learning Components	Considerations for Each Component	Instructional Strategy for Objective 6
Strategies for Objectives	Provide for motivation	Instructor shows photos, medical images, radiology reports, and anesthetic care plans from actual patient cases. *Authenticity* Invites learners to recall and share relevant clinical experiences. *Personalization*
	Relevance	Students must construct and apply anatomy knowledge so as to progress along the professional continuum from novice toward expert anesthesia provider by learning to: read/write/speak medical terminology; interpret medical images; assess clinical presentation of a patient; assimilate data to create a care plan for each patient; communicate data and care plans to patients and fellow clinicians; and physically perform clinical interventions/skills/tasks necessary to carry out the care plan.
	Confidence	Your ability to generate an anesthetic care plan and convey the plan to colleagues will result in safer patient care.
	Inform learners of objectives	6.1 Generate an anesthetic care plan (i.e., Plan A, B, C . . . G) in a best-practice sequence for a given patient with an H & P, medical image, and radiology report. 6.2 Convey the anesthetic care plan to anesthesiology colleagues and surgical care team members.
	Promote recall of prerequisites	Remind learners of medical terminology and basic anatomical structures.
	Link new content to existing knowledge/skills.	Remind learners of physiology, pharmacology, and anesthesiology from the previous semester. Remind learners of previous objectives.
Instructional Activities	Sequence based on hierarchy of skills	6.1 through 6.2 in order.
	Explain characteristics of concepts	Demonstrate formation of an anesthetic plan via case study. Communication with colleagues.

Learning Components	Considerations for Each Component	Instructional Strategy for Objective 6
	Provide examples and non-examples	Show abnormal medical images. Provide H&P, written radiology reports, and corresponding medical images. Provide anesthetic care plans.
	Create ways of organizing new into existing skills	Explicitly scaffold how to think about and generate an anesthetic care plan. Demonstrate possible consequences of miscommunication and non-communication on patient outcomes.
Learner Participation	Correlate practice with patient care; utilize authentic activities	Show medical images, H&P, radiology reports, anesthetic care plans and have learners perform 6.1 through 6.2 via SDL modules online, online discussion groups, and peer learning groups in class.
	Progress from easy to difficult	Present case studies of increasing complexity.
	Use simulations for practice in an authentic learning environment; promote transfer	SCALE: Describe the abnormality in medical terms as if giving report to a colleague. Discuss probable causes and effects of the abnormality. Discuss perioperative and anesthetic implications of abnormal structures. Write an anesthetic plan. Communicate the plan to colleagues.
	Give formative feedback	For incorrect plans, show clinical reasoning steps explicitly. Provide a plan-making checklist. Provide a communication/talking-points checklist.
Instructional Media	LMS online TLM	The Virtual Human Dissector Anatomy textbook (TBD) Medical imaging textbook (TBD) Netter Atlas Introductory PPT/presentation YouTube videos Assigned readings (textbooks and medical literature) Links to adjunct and advanced readings
	Classroom/lab	All the above plus: anatomic specimens, models, ultrasound machine, simulation manikins, living anatomy.
Assessment Strategy	Accommodate hierarchical nature of skills	Bloom's level 6: create – factual, conceptual, procedural, metacognitive Test items: describe, deduce, analyze, evaluate, create; short answer, essay, role-play conversation. Incorporate IM used for assignments.

Through the perspective of sociocultural situated learning, the teaching and learning models of cognitive apprenticeship and scaffolding can be used to create schemata for students by pairing anatomy topics with clinical tasks (Bransford et al., 2000). "By beginning with a task embedded in a familiar activity, it shows the students the legitimacy of their illicit knowledge and its availability as scaffolding in apparently unfamiliar tasks" (Brown, Collins, & Duguid, 1989, p. 38). Working retrograde from clinical practice (learning objective) toward basic science (anatomy topic), the first step is to select an unfamiliar task paramount to anesthesia with roots in anatomy. For example, AAs need to be able to interpret digital, medical images. The next step is to select a task to embed, specifically one that bridges the gap between unfamiliar and familiar activity (Brown et al., 1989). Cross-sectional anatomy is readily available online with sites such as The Virtual Human Project where a cadaver has been sliced into thin sections and photographed (Ackerman et al., 1995; Jastrow & Vollrath, 2002, 2003). Each color photograph has a corresponding black and white CT image. From familiar activities with cadavers, plastinated specimens, and models, students can draw on their illicit knowledge of 3D anatomy to identify 2D structures in cross-section (Brenton et al., 2007; Cuddy et al., 2013; McLachlan et al., 2004). Instructors will provide scaffolding for students to first learn 3D anatomy, then normal cross-sectional anatomy with corresponding CT images, and finally read abnormal CT images (Brenton et al., 2007; Brown et al., 1989; Jastrow & Vollrath, 2002, 2003; Phillips et al., 2013).

Instructors will assist students in deciphering the medical and anatomical language in the dictation report. The learning objective is that students will be able to create a mental image provided by the radiologist's written description of the CT image

(Shaffer, 2004). Following this ID process, additional radiological anatomy examples can be linked to anesthesiology procedures to create subsequent learning modules for the Applied Anatomy for Anesthesiology course.

Lastly, suitable strategies for motivating and engaging adult learners were examined and examined (Bonk & Khoo, 2014; Bonwell & Eison, 1991; Cercone, 2008; Filak & Sheldon, 2008; Keller, 1987; Kettle & Haubl, 2010; Reigeluth & Darwazeh, 1982; Wigfield & Eccles, 1992). Special attention was given to the subject matter context of medical anatomy, its relevance to clinical practice of anesthesiology, and ways in which situational authenticity and future work-related goals could be leveraged to attract and maintain learners' attention (Artino, Holmboe, & Durning, 2012; Dangerfield et al., 2000; DiLullo, McGee, & Kriebel, 2011; Drake, 2007; J. K. Gregory et al., 2009; Gupta, Westfall, Lechner, & Knuepfer, 2005; Mann, 1999; Smith et al., 2014). The instructor is responsible for fostering student-teacher relationships in the view of social presence in order to facilitate the CoP formation (Garrison et al., 1999).

Conclusions

I think it vital to the success of my students that ANES 525 Applied Anatomy for Anesthesiology has a cognitive-constructivist blended approach to instructional design. Learners need to master the full range of Bloom's Taxonomy to function appropriately in their future professional role as competent, effective, and safe novice anesthesia providers. Additionally, learners must develop self-reflective, personal practice improvement, and lifelong learning skills essential to advancing from novice toward expert anesthesia providers. It is through ID theory, models, and evidence-based best practices applied to course development for ANES 525 Applied Anatomy for

Anesthesiology that I intend to facilitate the transition of student learners to Certified Anesthesiologist Assistants. The next phase of the study is implementation and data collection.

Chapter 5: Methodology

Research Design, Implementation Strategies, and Evaluation of ANES 525 Applied Anatomy for Anesthesia Practice

This study was conducted via prospective, quasi-experimental, mixed methods research design (Gall, Gall, & Borg, 2010; Johnson & Onwuegbuzie, 2004; Onwuegbuzie & Leech, 2006; Tashakkori & Teddlie, 2010). Permission was obtained from the EUAAP program director, EU SOM, and EU IRB deferred to JHU HIRB. The Johns Hopkins University Homewood Institutional Review Board approved the study. The purposes of the study were to:

1. Describe changes to a traditional human anatomy course, specifically the transition from a dissection based basic science course into a technology and clinically based course.
2. Assess, compare, and discuss student achievement on pre/posttest scores and course grades.
3. Assess, describe, and discuss student perceptions of teaching and learning materials and instructional methods.

Participant Selection

Enrollment in ANES 525 is mandatory for all first-year AA students in the EUAAP, and completion with a grade of C or better on a traditional A-F grading scale is a requirement for graduation (EUAAP, 2015). Mandatory enrollment creates the situation of a non-random sample, but sampling error is irrelevant because the entire population of interest is also the target, accessible, and sample populations (Gall et al., 2010). Thirty-seven first-year AA students were enrolled in ANES 525 during fall semester 2015.

Ethical concern for equal treatment of students impeded random assignment to an experimental or control group. As such, students served as their own controls within the pre/posttest design (Gall et al., 2010). Also, comparing cohort 2015 student demographics to cohorts 2014 and 2013 populations as historical controls assessed population validity. (Gall et al., 2010).

Participant Informed Consent was obtained such that students could choose whether or not to participate in the study. All students consulted to participate in the study ($N = 37$). Attrition from the study was therefore limited to students who either withdrew or were dismissed from the EUAAP prior to the course end date. In this case, attrition was zero.

Measurable Indicators

Student Demographics

Usual and customary demographic indicators in medical education research studies on student achievement (Azer, 2011; Phillips et al., 2013) and student perceptions (Johnston & McAllister, 2008; Machado et al., 2013; Smith et al., 2014) include measures of gender, age, scholastic aptitude, education level, and prior experience. Specific indicators for this study are: (a) gender; (b) age at matriculation; (c) prerequisite GPA; (d) composite GRE or MCAT score; (e) highest coursework level completed; (f) prior anatomy and physiology coursework; and (g) prior healthcare experience.

Student Achievement

Usual and customary indicators of learning in medical education research studies on student achievement include pre/posttests and course grades (Azer, 2011; Baker et al., 2013; Cuddy et al., 2013; Husmann et al., 2009; Latorre et al., 2007; Phillips et al., 2013).

The ACGME/ABMS Joint Initiative Toolbox of Assessment Methods (2000) described *written examination (e.g., MCQ)* as a useful assessment tool to "sample medical knowledge and understanding of a defined body of knowledge" (p. 18).

In addition to written exams, course grades were calculated from various assignments in the form of written case reflections, final projects, and small group PBL deliverables (e.g., SCALEs). The ACGME/ABMS (2000) used the term *portfolios* to describe:

> a collection of products prepared by the resident [student] that provides evidence of learning and achievement related to a learning plan. A portfolio typically contains written documents but can include video or audio-recordings, photographs, and other forms of information. Reflecting upon what has been learned is an important part of constructing a portfolio . . . Portfolios are most useful for evaluating mastery of competencies that are difficult to evaluate in other ways. (p. 11)

These assignments afforded students opportunities for reflection, collaborative learning, and creative expression, and provided assessment tools for the instructor to make summative evaluations of students' mastery of content, skills, concepts, and knowledge application (Hardiman, 2012; Hardiman & Whitman, 2014). Research and evaluation questions, hypotheses, and indicators pertaining to the construct of student achievement are presented in Table 17.

Table 17

Student Achievement: Questions, Objectives, and Operational Definitions

Research Questions
RQ1: How will instructional strategies utilized in ANES 525 impact exam scores?
RQ2: How will instructional strategies utilized in ANES 525 impact course grades?
Hypothesis/Objectives
H_1: Impact of IS utilized in ANES 525 on exam scores will be positive.
H_2: Impact of IS utilized in ANES 525 course grades will be positive.
O_1: To determine effectiveness of IS as measured by pre/posttest scores.
O_2: To determine effectiveness of IS as measured by course grades.
O_3: To better understand how students learn anatomy.
Evaluation Questions
EQ1: How did instructional strategies utilized in ANES 525 impact exam scores?
EQ2: How did instructional strategies utilized in ANES 525 course grades?
Operational Definitions of Constructs, Variables, and Measurable Indicators

Note. Student achievement: Students' quantitative *exam scores* on an initial written assessment *(pretest)* and three written exams *(posttest* = pretest questions divided among three written exams per the course topic schedule; raw scores added for posttest total). Students' quantitative *course grades* are prescribed by the syllabus.

Student Perceptions

Teaching and learning materials (TLM) are the resources an instructor uses to deliver instruction and to assist and support learning (University College Cork, 2014). TLM occupy a major role in making knowledge accessible to learners, and can motivate students to engage with knowledge in different ways (University College Cork, 2014). IM are the interactions between instructors and students, and between students and TLM (University College Cork, 2014). Atkins and Brown (1988), organized methods of affording students the opportunity to learn on a continuum from teacher-centered teaching (i.e., lectures), where instructors hold the locus of control, to student-centered learning (i.e., independent study), where students hold the locus of control. While listing and describing TLM and IM as moderator variables is straightforward, student perceptions of both are inherently more difficult to define and measure. A variety of studies informed this research on possible indicators and sampling methods to elicit qualitative data on student perceptions of learning experiences (Adamczyk et al., 2009; Fruhstorfer et al., 2011; Ivanusic et al., 2010; Johnston & McAllister, 2008; Machado et al., 2013; Smith et al., 2014; Smith & Mathias, 2007; Smith & Mathias, 2009; Smith & Mathias, 2010; Smith & Mathias, 2010; Smith & Mathias, 2011).

Fortuitously, the literature review identified an evidence-based survey questionnaire designed to ascertain students' perceptions and experiences, which had been previously validated and reported as the Anatomy Learning Experiences Questionnaire (ALE). The ALE was divided into the following clusters:

- The activities students prefer to do to learn anatomy.
- Student experiences and feelings about working on cadavers.
- The problems students encountered.
- How students currently use their anatomy knowledge.
- Students' overall perceptions of anatomy (Smith et al., 2013, p. 272).

Research and evaluation questions, hypotheses, and indicators pertaining to the construct of student perception are presented in Table 18.

Table 18

Student Perception - Questions, Objectives, and Operational Definitions

Research Questions
RQ1: How will students perceive TLM utilized in ANES 525?
RQ2: How will students perceive IM utilized in ANES 525?
RQ3: Which TLM will students perceive as effective for learning anatomy?
RQ4: Which IM will students perceive as effective for learning anatomy?
Hypothesis/Objectives
H_{1}: Student perception of TLM utilized in ANES 525 will be positive.
H_{2}: Student perception of IM utilized in ANES 525 will be positive
O_1: To determine effectiveness of TLM as perceived by students.
O_2: To determine effectiveness of IM as perceived by students.
O_3: To better understand how students learn anatomy.
Evaluation Questions
EQ1: How did students perceive TLM and IM utilized in ANES 525?
EQ2: Which TLM did students perceive as effective for learning anatomy?
EQ3: Which IM did students perceive as effective for learning anatomy?
Operational Definitions of Constructs, Variables, and Measurable Indicators
Student perception: Utilization of Likert-type survey questions on *effectiveness* of materials and methods for learning anatomy, learning *experiences*, and *perceptions* of the course. Collected from students as responses to MCQs: *agree, somewhat agree, neutral, somewhat disagree, disagree;* and rank order*: most effective to least effective.*

Instruments and Tools

Pretest/posttest

Following the Dick and Carey model (2005) of instructional design process, a pre/posttest was developed by the instructor during the *develop assessment instruments* phase, prior to implementation of the instructional intervention. This design aspect can increase validity by: (a) eliminating instructor-introduced bias resultant of concordantly teaching and developing exams; (b) separating PI and instructor roles; and (c) increasing the instructor's fidelity of implementation by deterring changes to the course content, schedule, or exams (Dick et al., 2005; Gall et al., 2010; Shadish, Cook, & Campbell, 2002).

The written assessment design and development process for pre/posttest and exam questions was based on medical education best-practices for writing MCQs (Case & Swanson, 2002) and pre/posttest methodology by Azer (2011) and Phillips et al. (2013). The pretest consisted of 40 MCQs, all single best answer. The PI was blinded to individual student scores, but did assess group responses for each question with regard to keying of answers and item analysis. No questions required re-keying, and all questions were approved for inclusion on the posttest.

Pretest questions were divided among three written exams based on topic alignment. Each exam contained additional MCQs and matching questions. Pre/posttest questions were extracted as a subset for each exam and amalgamated to form a simulated posttest (see Table 19).

Table 19

Simulated Posttest From Three Course Exams

Question type	Pretest	Exam 1	Exam 2	Exam 3	Posttest
MCQ - pre/posttest	40	13	16	11	40
MCQ - Other	0	28	32	24	0
Matching	0	43	42	35	0
Total	40	84	90	71	40

Course Grades

The calculation of course grades was slightly modified from the ANES 525 syllabus (see Appendix G) to (a) account for lack of quizzes, (b) include case reflections in the SCALEs category, and (c) increase weight of final projects to reflect requisite student time and effort (see Table 20). Students were informed of the modification in week 11.

Table 20

Modified Course Grade Weighted Percentages for Assessment Methods

Assessment methods	Original % per syllabus	Modified %
Written exams	45	50
Quizzes	5	0
SCALEs	20	35
Case reflections	20	0
Final projects	10	15

Questionnaire: Student Perceptions of ANES 525

Because students' learning experiences and subsequent satisfaction are dependent upon the learning environment, investigating and seeking understanding of how AA students perceive learning anatomy is important to informing further iterations of the course (Smith et al., 2014). Smith and Mathias (2007) designed the ALE to ascertain students' perceptions and experiences of learning anatomy. For the needs assessment, written permission was obtained from Dr. Claire F. Smith (personal communication, March 19, 2014) for use and adaptation of the ALE, such that the PI developed a questionnaire, Student Perceptions of BAHS 500 (see Chapter 3).

In summer of 2015, the PI redesigned the instrument to include questions on TLM, IM, and learning experiences reflective of the ANES 525 course design, and to eliminate irrelevant questions. The new survey instrument, Student Perceptions of ANES 525 (see Appendix H), consisted of 49 questions to assess student perceptions. A 5-point Likert scale ranging from 1 to 5 (disagree, somewhat disagree, unsure/neutral, somewhat agree, agree) was used to rate 45 questions. Additionally, a rank-order drop-down list was used to rate three questions ranging from 1 ("most effective") to 9 ("least effective") for TLM, from 1 to 10 for IM, and from 1 to 6 for assessment methods. One MCQ, one open-ended question, and 3 comments boxes were incorporated.

Questionnaire and Matriculation Files: Student Demographics

Matriculation files on EUAAP students are maintained in an electronic database, File Maker Pro version 14, which is searchable by student name, identification number, and cohort. The following information was collected for every student in cohorts 2015, 2014, and 2013: (a) identification number; (b) gender; (c) age at matriculation; (d) prerequisite GPA; (d) composite GRE or MCAT score; and (e) anatomy course grade.

Items of interest not contained within the database were collected via the demographics section of the survey questionnaire for cohort 2015: (a) highest coursework level completed; (b) prior healthcare experience; and (c) prior anatomy and physiology coursework.

Procedure

Course Design and Implementation

The formal course description as approved by Emory University, the Southern Association of Colleges and Schools (SACS), and the Accreditation Review Committee for Anesthesiologist Assistant Education (ARC-AA) to replace BAHS 500:

ANES 525 Applied Anatomy for Anesthesia Practice.

> Fall Semester. Credit 2 hours. Gross anatomy, histology, and medical imaging. Anatomical terms, structures, and relationships emphasizing functional significance and application in clinical anesthesia situations. Laboratory provides demonstrations on models, prosections, and digital media. Course topics align with ANES 536A Anesthesiology Practice I and ANES 505B Human Patient Simulation Lab II. (EUAAP, 2015)

ANES 525 was designed around the previously stated course goal, four course aims, and five learning objectives (see Appendix F).

Per traditional university practices and those adopted specifically by EU, e). h credit hour is equivalent to 1 lecture hour or 4 lab hours, and 2 out of class study hours per week (J. R. Hall, personal communication, March 13, 2014). ANES 525 for 2 credit hours could be arranged as several weekly scenarios (see Table 21).

Table 21

Possible Divisions of Contact and Study Hours for a 2 Credit Hour Course

Scenario	Out of Class	Lecture	Lab	F2F
Lecture only	4	2	0	2
Lecture & lab	4	1	4	5
Lab only	4	0	8	8

In the flipped classroom model, lectures are eliminated, so all other activities could be construed as lab hours. However, elimination of formal lectures subsequently increases the out of class preparation time allotment necessary for basic content knowledge acquisition (Allen & Seaman, 2013; Garrison et al., 2010; Sams & Bergmann, 2013). Directives for flipped courses are non-existent at EU. Based on several reports of similarly redesigned medical anatomy courses (McLaughlin et al., 2014; Ogard, 2014; Rizzolo et al., 2011; Rizzolo et al., 2010) and my teaching experience, I made the executive decision to blend the course at 50% content delivery online and 50% f2f teacher-student and student-student interaction. Thus, students were allotted 5 out of class hours per week to acquire basic content knowledge via the LMS learning modules and self-directed study in order to prepare for instructor-facilitated, student-centered applied learning f2f classroom hours at 5 per week. The course met f2f for labs, small group activities, discussions, and student presentations over the 15 week semester. Each week, students participated in a 3 hour session Tuesday morning or Tuesday afternoon with an approximate 18:1 student-teacher ratio, and a 2 hour session Thursday afternoon at 37:1.

The course was presented in a systems-based approach. Each system was introduced via instructor designed and developed learning modules made available to students online via the EU supported learning management system (LMS) Blackboard Learn 9.1 SP14. Principal course resources comprising each learning module were:

- Lab Lists: instructor provided PDFs of learning objectives and anatomic terms/structures for identification.
- Readings: PDFs, e-book links, e-Reserve journal links, and external website links.
- Images: PDFs, e-book links, Access Medicine links, and external website links.
- Videos: cross-referenced to and accessed via the instructor's YouTube channel – Khan Academy, Access Medicine, and Hand Written Tutorials.
- Assignments: SCALEs, case reflections, projects, and discussion board.

Students supplemented LMS content with resources of their choosing.

Teaching and learning materials. In addition to electronic resources made available via Blackboard, students had access to numerous instructor-provided resources. For the purpose of this study, TLM are considered inputs and independent variables that are hypothesized to affect outcomes of student achievement and student perceptions. TLM for learning anatomy utilized in ANES 525 were

- textbooks and e-textbooks,
- digital and online material,
- documents provided by the course,
- medical images (CT, MRI),
- cadavers and specimens,
- virtual cadavers,

- living anatomy,
- plastic models, and
- medical equipment (ultrasound, arterial line, laryngoscope).

Instructional methods. For the purpose of this study, IM are considered inputs and independent variables that are hypothesized to affect outcomes of student achievement and student perceptions. IM for learning anatomy utilized in ANES 525 were

- creating a final project,
- watching pre-recorded lectures/PPTs,
- reading clinical journals,
- clinician based teaching,
- writing case reflections,
- working through problem based learning,
- studying in small groups,
- engaging in discussion boards,
- preparing a presentation, and
- watching presentations.

Course schedule. The day-to-day course topic schedule with aligned SCALEs, activities, and exam dates is presented in Appendix I.

Pre/posttest and Written Exam Administration

The pretest was administered on the first day of class. Students were informed the pretest was for instructor information gathering, and would not be part of the course grade. All students (*N* = 37) took the written pretest (40 MCQ, all single best answer).

Scores were not reported to students, and questions were not released nor discussed. The PI was blinded to individual student scores, but did assess group responses for each question with regard to keying of answers.

Three written exams for course grades were scheduled approximately 1 every 5 weeks. Exams were stand-alone (not comprehensive), and contained topics covered in the preceding weeks. Each pre/posttest question was embedded in one exam based on topic alignment. Exams contained additional MCQs and matching questions. Pre/posttest question responses were extracted as subsets and amalgamated to form a simulated posttest.

Activities and Assignments for Summative Assessment

Throughout the semester, students completed various student-centered applied learning exercises (SCALEs) and produced written (including text and images) deliverables that were uploaded as MS Word documents to Blackboard LMS for feedback and summative grading. SCALEs consisted of case reflections, PBL, small group discussions with collaborative deliverables (i.e., worksheets). Most SCALEs were completed in class/lab in small groups, and a few were individual assignments completed out of class.

Additionally, students chose two final projects for submission at the end of the semester. Class time was allotted for collaborative work sessions and formative feedback from the instructor. Students were given the option to present their projects to the class.

Directives, grading rubrics, and submission timelines accompanied all assignments. The instructor provided feedback and posted grades via Blackboard LMS functionality. Course grades were calculated by the previously discussed method (see

Table) and submitted to EUAAP administrators for submission to EU at the end of the semester.

Data Collection and Analysis

The mixed-methods study design allowed quantitative and qualitative data collection (Tashakkori & Teddlie, 2010; Johnson & Onwuegbuzie, 2004; Gall, Gall, & Borg, 2010). Data for independent, dependent, and moderator variables were collected by five measures: (a) pre/posttest; (b) course grades; (c) student survey questionnaire; (d) student matriculation file review; and (e) course documents review (see Table 22).

Table 22

Data Collection Matrix

Indicator	Role of Indicator	Data Source
Teaching and learning materials	Input	Course documents
Instructional methods	Input	Course documents
Student achievement	Control	Pretest score
Student achievement	Outcome	Posttest score
Student achievement	Outcome	Course grade
Student perceptions of TLM	Outcome	Questionnaire
Student perceptions of IM	Outcome	Questionnaire
Student demographics Prior coursework	Moderator	Questionnaire
Student demographics Prior clinical experience	Moderator	Questionnaire
Student demographics Scholastic aptitude	Moderator	Matriculation file GRE/MCAT score
Student demographics Scholastic aptitude	Moderator	Matriculation file Prerequisite GPA
Student demographics Gender	Moderator	Matriculation file
Student demographics Age	Moderator	Matriculation file

Student Achievement

The pretest and written exams were administered in paper format, and student responses were recorded on mark reader scoring sheets. Logic eXtension Resources LXR*TEST version 6.1 testing software was utilized for item banking, test construction, scoring, and analysis. Measures of item analysis, test validity, and reliability were performed (Gall et al., 2010; Shadish et al., 2002). Content-related evidence of test validity was supported by alignment of test questions with assigned readings and specific learning objectives on Lab Lists. Comparing students' individual scores on the posttest and the average of the three exam scores supported convergent evidence of test validity.

Students' scores were recorded for the pretest; students' scores on the three subsets of pre/posttest questions were summed and recorded as the posttest score. Students served as their own controls via normalization of pre/posttest scores (Glantz, 2012; Phillips et al., 2013; Shadish et al., 2002).

Course grades were calculated from written exam and assignment scores recorded by the instructor in Blackboard LMS. A research assistant de-identified the data, and presented it to the PI/instructor after course grades were submitted. The PI entered data into SPSS.

Student Demographics

A research assistant collected student demographic data from matriculation files in FileMaker Pro version 14 for cohorts 2015, 2014, and 2013. All data was de-identified, and presented to the PI/instructor after course grades were submitted. The PI entered data into SPSS.

Student Perceptions

The PI administered the survey questionnaire to the students at the beginning of the spring 2016 semester. The survey questionnaire was administered online via a Survey Monkey account held by EUAAP. Students were given a Participant Informed Consent with study details, and either chose to consent and proceed, or chose to opt-out (See Appendix F). Survey questionnaire responses were collected and computed with Survey Monkey, and data was downloaded to Adobe Acrobat Pro, MS Excel, and SPSS for further analysis. Additional student demographic data was collected and added to SPSS by the PI. Descriptive and inferential statistics were computed with IBM SPSS Statistics version 23.

Chapter 6: Findings

Statistical Analysis, Results, and Discussion

The survey questionnaire was administered to 37 first-year EUAAP students who had taken ANES525 in the fall semester of 2015. All students gave consent and agreed to participate in the study. A total of 37 students completed the demographic portion of the survey; 36 students completed the student perceptions portion of the survey, giving a response rate of 97%.

Data gathered from student matriculation files, grade reports, and the questionnaire were downloaded and/or entered to Adobe Acrobat Pro, MS Excel, and SPSS. Qualitative data were coded via standard practices (i.e., female = 1; male = 2; Likert scale 1 through 5), and maintained in an SPSS codebook. A *P* value of $p < 0.05$ was set to determine a significant difference at a 95% CI for all analyses, unless otherwise indicated. An *a priori* power analysis revealed adequate power to identify a significant difference in groups if present. The first level of analysis for both demographic and outcome data was descriptive statistics. Parametric tests were utilized for analysis of between group and within-group differences for scale (i.e., continuous and rank-order responses) and ordinal (i.e., Likert-type responses) data. Nonparametric tests were used to compare categorical frequencies between groups and within-group data. RQ, null hypotheses, and EQs are answered and discussed one set at a time.

Historical Controls

H_0: There are no significant differences on demographics among cohorts 2015, 2014, and 2013.

To assess population, sample, and target validity, demographic data was compared across cohorts for the current year (e.g., 2015) and previous years (e.g., 2014 and 2013). GRE Verbal Reasoning and Quantitative Reasoning scores for students who took the General Test prior to August 1, 2011 were transitioned to current scale scores using concordance tables (Educational Testing Service, 2015). GRE Composite scores were calculated by adding Verbal Reasoning and Quantitative Reasoning scores. A Kruskal-Wallis test of independent samples was performed to assess differences among cohorts with regard to age at matriculation (age), GRE Composite scores (GRE), MCAT Composite scores (MCAT), and GPA for EUAAP prerequisite courses (preGPA). There were no significant differences in distribution of these four variables across the three cohorts. An independent samples *t*-test for equality of means and a Levene's test for equality of variances showed no significant differences in means of these four variables between genders. ANOVA showed no significant differences in means of the four variables or gender across the three cohorts. Thus, the null hypothesis was accepted: The target population for this study is no different than historical controls. Therefore, results and outcomes can be generalized to future, similar, EUAAP cohorts.

Cohort 2015 Demographics

H_0: There are no significant relationships among demographics within cohort 2015.

Several additional tests were performed on demographic data specific to the cohort 2015. Linear regression analysis of GRE and MCAT scores showed a perfect positive correlation ($r = 1.00$, $p < 0.01$). The null hypothesis was rejected, but because only two students took both exams, this finding is not practically significant. However, this finding supports the hypothesis that high scores on one standardized test would predict high scores on other, similar standardized tests.

Among the variables age, gender, preGPA, course grade, highest degree, anatomy and physiology coursework (totalapc), and clinical experience (clinicalexp), only age and highest degree showed a significant positive correlation on linear regression analysis ($r_S = 0.337$). However, the oldest student (age = 40) was the only student with a doctorate degree, and two students (age = 30, 35) had a master degree where the mean cohort age = 28 ± 4.9. The practical significance of the age-degree relationship must take into consideration the time in years required to complete an advanced degree; as age increases, so too does the time afforded to complete a master or doctorate degree. "For the 2003 doctorate recipients, the median total time from baccalaureate to doctorate was 10.1 years, while the median registered time was 7.5 years and the median age at doctorate was 33.3 years." (Hoffer & Welch Jr, 2006, p. 1). This finding suggests that the cohort 2015 sample is representative of the general population. Of note, the student age 40 is greater than 2 standard deviations from the cohort mean age, and thus could be considered an outlier (Gall et al., 2010).

Student Achievement

Pre/posttest

RQ1: How will instructional strategies utilized in ANES 525 impact posttest scores?

H_1: Instructional strategies utilized in ANES 525 will positively impact posttest scores: There is a significant difference between pretest scores and posttest scores.

H_0: There is no significant difference between pretest scores and posttest scores.

EQ1: How did instructional strategies utilized in ANES 525 impact posttest scores?

Examination of histograms of pretest, posttest, and gain scores indicated the distributions were close to normal. A *t*-test showed a significant difference between pretest and posttest mean scores (M_{pre} = 55, *SD* = 9.5, M_{post} = 89, *SD* = 8.6, *p* = 0.000). The null was rejected, and a positive impact of instructional strategies was evidenced, thus indicating that learning occurred.

Within-subject correlation between pretest and posttest scores provides an estimate of the consistency of the intervention impact across students. Pearson's correlation coefficient calculated between pretest and posttest scores was statically significant (*p* = 0.032) and showed a moderate (*r* = 0.359) measure of strength of a positive linear relationship. Thus, the rank ordering of students on the pretest is similar to the posttest, the level of learning is similar across students, and the Type 1 error is estimated to be relatively small.

Course Grades

RQ2: How will instructional strategies utilized in ANES 525 impact course grades?

H_2: Instructional strategies utilized in ANES 525 will positively impact course grades: There are significant relationships among posttest scores and course grades.

H_0: There are no significant relationships among posttest scores and course grades.

EQ2: How did instructional strategies utilized in ANES 525 impact course grades?

All students met course-passing expectations with course grades ranging from 87% to 96% (*M* = 92, *SD* = 2.5). Within-subject correlation between posttest scores and course grades provides an estimate of the consistency of the intervention impact across students. Pearson's correlation coefficient calculated between posttest scores (*M* = 88.54, *SD* = 8.63) and course grades (*M* = 91.72, *SD* = 2.49) was statically significant (*p* =

0.000) and showed a strong (r = 0.632) measure of strength of a positive linear relationship. Thus, the rank ordering of students on the posttest is similar to the course grades, the level of learning is similar across students, and the Type 1 error is estimated to be relatively small.

Additional Findings

Table 23 displays Pearson correlation coefficients among all student achievement variables. Based on previous findings, it follows that pretest scores and course grades show a significant (p = 0.002) positive correlation (r = 0.503). It is interesting to note there are no significant relationships between demographic variables (GRE and preGPA) and intervention variables (pretest, posttest, and course grade), so demographic variables do not show a moderator effect on the intervention.

Table 23

Student Achievement Correlations

Variable	*M*	*SD*	*N*	Stat	Posttest	Pretest	Course Grade	GRE	preGPA
Posttest	88.54	8.63	36	*r*		.359*	.632**	.099	.200
				p		.032	.000	.585	.242
Pretest	55.19	9.44	36	*r*	.359*		.503**	.325	.191
				p	.032		.002	.065	.266
Course Grade	91.72	2.49	36	*r*	.632**	.503**		-.102	.236
				p	.000	.002		.571	.166
GRE	309.12	6.85	33[a]	*r*	.099	.325	-.102		.291
				p	.585	.065	.571		.100
preGPA	3.50	0.36	36	*r*	.200	.191	.236	.291	
				p	.242	.266	.166	.100	

Note: [a]Three students took the MCAT, not the GRE.
*. Correlation is significant at the 0.05 level (2-tailed). **. Correlation is significant at the 0.01 level (2-tailed).

Student Perceptions

Student responses for Likert-type questions were reduced from five into three categories as follows: Agree (A) = agree and somewhat agree; Neutral (N) = unsure/neutral; Disagree (D) = somewhat disagree and disagree. The majority of results are discussed in three categories; select results are discussed in the original five categories to permit deeper understanding. Means and standard deviations were calculated for Likert scores on the survey questionnaire. Nonparametric Kruskal-Wallis analyses were used to investigate the difference in students' perceptions with regard to gender dominance.

Student Perceptions of TLM

RQ3: How will students perceive TLM utilized in ANES 525?

H_3: Students will perceive TLM utilized in ANES 525 as effective for learning anatomy: More than 50% of students agree (agree or somewhat agree) each TLM is effective for learning anatomy.

H_0: There are no significant relationships among student perceptions of TLM effectiveness.

EQ3: How did students perceive TLM utilized in ANES 525?

Table 24 ALE Cluster 1: Your Learning and TLM shows some students perceived each of the nine TLM as effective for learning anatomy. All students (100%) agreed that digital material and plastic models were effective. Students agreed that course documents, medical equipment, textbooks, living anatomy, medical imaging, and cadavers were also effective at greater than 50% (range 89% - 72% respectively), thus supporting $H_{3.}$

Table 24

ALE Cluster 1: Your Learning and TLM

			Response %			Likert 1-5	
ALE	SM	Question	A	N	D	*M*	*SD*
1	13	I found reading textbooks (paper and e-books) an effective way of learning anatomy.	78	6	16	2.08	1.11
2	14	I found digital and online material an effective way of learning anatomy.	10	0	0	1.19	0.40
4	15	I found medical imaging material an effective way of learning anatomy.	75	14	11	1.92	1.03
3	16	I found documents provided by the course an effective way of learning anatomy.	89	6	5	1.61	0.84
6	17	I found cadavers and cadaveric specimens an effective way of learning anatomy.	72	14	14	2.14	1.15
2	18	I found virtual cadavers an effective way of learning anatomy.	28	58	14	2.78	0.99
	19	I found living anatomy an effective way of learning anatomy.	78	17	5	1.92	0.97
	20	I found plastic models an effective way of learning anatomy.	10	0	0	1.44	0.50
	21	I found using medical equipment an effective way of learning anatomy.	86	3	11	1.72	0.97

Note. For this and similar tables: *N* = 36; ALE = Anatomy Learning Experiences Questionnaire; SM = Survey Monkey Questionnaire; Response % A = Agree + Somewhat Agree, N = Unsure/Neutral, D = Somewhat Disagree + Disagree, A + N + D = 100%; Likert scale 1 = Disagree, 2 = Somewhat Disagree, 3 = Unsure/Neutral, 4 = Somewhat Agree, 5 = Agree

Only 28% agreed (A = 14%; SA = 14%) that virtual cadavers were effective, 58% were neutral, and 14% disagreed (SD = 8%; D = 6%). This finding has several possible explanations. Of all the TLM, virtual cadavers were least emphasized by the instructor as applicable to clinical practice of anesthesia, and had the fewest number of inclusions on Blackboard within learning modules. Cost of purchasing commercial virtual cadaver software access by either the EUAAP for student use, or as a course requirement for students to self-finance, were considered by the course director and EUAAP administrators to be unnecessarily high given the multitude of acceptable and less costly TLM. Students were encouraged to seek out and share virtual cadaver resources. The list of virtual cadaver resources given by nine students reveals an initiative toward self-directed learning:

- e-Textbook supplement
- CD-ROM
- Cadaver e-book
- Anatomy app
- Other universities' websites
- Anatomy & Physiology Revealed
- Essential Anatomy (listed by three students).

RQ4: Which TLM utilized in ANES 525 will students perceive as most effective?

H_4: Students perceive TLM utilized in ANES 525 as having different levels of effectiveness for learning anatomy.

H_0: There are no significant relationships among student perceptions of TLM effectiveness.

EQ4: Which TLM utilized in ANES 525 did students perceive as most effective?

To see if gender exerted any effect on students' perception of TLM, a Kruskal-Wallis test was performed. No TLM showed significant gender-bias (see Table 25).

Table 25

Independent-Samples Kruskal-Wallis Test of Gender Differences in IM

Null Hypothesis	*p*	H_0 Decision
The distribution of I found reading textbooks an effective way of learning anatomy is the same across categories of gender.	.119	Retain
The distribution of I found digital and online material an effective way of learning anatomy is the same across categories of gender.	.278	Retain
The distribution of I found medical imaging material an effective way of learning anatomy is the same across categories of gender.	.960	Retain
The distribution of I found documents provided by the course an effective way of learning anatomy is the same across categories of gender.	.545	Retain
The distribution of I found cadavers and cadaveric specimens an effective way of learning anatomy. is the same across categories of gender.	.907	Retain
The distribution of I found virtual cadavers an effective way of learning anatomy. is the same across categories of gender.	.709	Retain
The distribution of I found living an effective way of learning anatomy. is the same across categories of gender.	.205	Retain
The distribution of I found plastic models an effective way of learning anatomy. is the same across categories of gender.	.713	Retain
The distribution of I found using medical equipment an effective way of learning anatomy. is the same across categories of gender.	.712	Retain

Table 26 shows the average raking computed for SM 32 and the corresponding percentage of students that agreed the TLM was effective for SM 13 – 21. Additionally, the Spearman's rho bivariate correlation coefficient between students' responses for SM 13 – 21 and matched responses from SM 32 are reported. Ranking order and effectiveness perceptions for each TLM showed significant positive correlations except *cadavers* (which was very close at $p = 0.051$) and *plastic models* ($p = 0.186$). It is interesting that all students agreed or somewhat agreed that plastic models were effective TLM, but ranked plastic models as 4th effective overall. This may be affected by students' interpretation of the term *effective*, and in future survey iterations, perhaps the term *preferred* TLM for learning anatomy may elicit different responses. Ranking order and correlation analysis demonstrate further support of students' perception of *virtual cadavers* as the least effective TLM.

Table 26

Your Learning and TLM Ranking

SM	Question	*M*	A%	r_S	*p*
32	Rank the materials for learning anatomy from most effective (1) to least effective (9).				
14	1. Digital and online material	2.92	100	0.450**	0.006
13	2. Textbooks and e-textbooks	3.89	78	0.353*	0.034
16	3. Documents provided by the course	4.50	89	0.429**	0.009
20	4. Plastic models	4.67	100	0.226	0.186
15	5. Medical images	5.44	75	0.422*	0.010
19	6. Living anatomy	5.58	78	0.578**	0.000
17	7. Cadavers and specimens	5.67	72	0.327	0.051
21	8. Medical equipment	5.81	86	0.558**	0.000
18	9. Virtual cadavers	6.53	28	0.387*	0.02

Note. M = mean rank score, A% = agree + somewhat agree.
*Correlation is significant at the 0.05 level (2-tailed). **Correlation is significant at the 0.01 level (2-tailed).

Student Perceptions of IM

RQ5: How will students perceive IM utilized in ANES 525?

H_5: Students perceive IM utilized in ANES 525 as effective for learning anatomy: More than 50% of students agree or strongly agree each IM is effective for learning anatomy.

H_0: There are no significant relationships among student perceptions of IM effectiveness.

EQ5: How did students perceive IM utilized in ANES 525?

Table 27 shows some students perceived each of the nine IM as effective for learning anatomy. Contrary to TLM, no IM showed all students in agreement (where A + SA = 100%) of its effectiveness. More than 50% of students agreed that *working through PB, clinician based teaching, preparing a presentation, creating a final project, watching pre-recorded lectures, studying in small groups,* and *watching a presentation* were effective (range 89% - 58% respectively), thus supporting H_5. *Writing case reflections* was perceived by 42% of students who agreed it was effective for learning anatomy. Perhaps in future iterations of AENS 525, the instructor could provide more examples of case reflections and could assign more case reflection deliverables; for fall 2015, only two were assigned. Of note, only 31% agreed that *reading clinical journals* and *engaging in discussion boards* were effective. Possibly, the low number of assignments that incorporated journals (n = 3) and discussion boards (n = 1) as IM could have affected the perceived value of these particular IM. Admittedly, the instructor throughout the course could have placed more emphasis on the discussion boards. Nevertheless, the first iteration of ANES 525 in the flipped classroom framework permitted what the instructor considered adequate in-class discussion, discourse, and collaboration opportunities.

Table 27

ALE Cluster 1: Your Learning and IM

ALE	SM	Question	Response % A	Response % N	Response % D	Likert 1-5 *M*	Likert 1-5 *SD*
	22	I found writing case reflections an effective way of learning anatomy.	42	25	33	2.86	1.20
2	23	I found watching pre-recorded lectures/PPTs/YouTube an effective way of learning anatomy. (e.g. flipped classroom)	64	19	17	2.31	1.24
7	24	I found clinician based teaching an effective way of learning anatomy.	78	14	8	1.81	0.98
	25	I found reading clinical journals an effective way of learning anatomy.	31	25	43	3.31	1.24
	26	I found engaging in discussion boards an effective way of learning anatomy.	31	25	43	3.22	1.12
	27	I found studying in small group an effective way of learning anatomy.	62	22	6	2.06	0.86
	28	I found creating a final project an effective way of learning anatomy.	69	8	23	2.19	1.24
	29	I found working through problem-based learning exercises an effective way of learning anatomy.	89	11	0	1.83	0.61
	30	I found preparing a case/topic presentation an effective way of learning anatomy.	78	14	8	2.06	0.96
	31	I found watching a case/topic presentation an effective way of learning anatomy	58	25	17	2.50	1.06

RQ6: Which IM utilized in ANES 525 will students perceive as most effective?

H_6: Students perceive IM utilized in ANES 525 as having different levels of effectiveness for learning anatomy.

H_0: There are no significant relationships among student perceptions of IM effectiveness.

EQ6: Which IM utilized in ANES 525 did students perceive as most effective?

To see if gender exerted any effect on students' perception of IM, a Kruskal-Wallis test was performed. No IM showed significant gender-bias (see Table 28). The null hypothesis was not rejected for any IM with regard to gender.

Table 28

Independent-Samples Kruskal-Wallis Test of Gender Differences in IM

Null Hypothesis	p	H_0 Decision
The distribution of I found writing case reflections an effective way of learning anatomy is the same across categories of gender.	.434	Retain
The distribution of I found watching pre-recorded lectures/PPTs/YouTube an effective way of learning anatomy is the same across categories of gender.	.717	Retain
The distribution of I found clinician based teaching an effective way of learning anatomy is the same across categories of gender.	.643	Retain
The distribution of I found reading clinical journals an effective way of learning anatomy is the same across categories of gender.	.143	Retain
The distribution of I found engaging in discussion boards an effective way of learning anatomy is the same across categories of gender.	.921	Retain
The distribution of I found studying in small group an effective way of learning anatomy is the same across categories of gender.	.893	Retain
The distribution of I found creating a final project an effective way of learning anatomy is the same across categories of gender.	.715	Retain
The distribution of I found working through problem-based learning exercises an effective way of learning anatomy is the same across categories of gender.	.100	Retain
The distribution of I found preparing a case/topic presentation an effective way of learning anatomy is the same across categories of gender.	.619	Retain
The distribution of I found watching a case/topic presentation an effective way of learning anatomy is the same across categories of gender.	.920	Retain

Table 29 shows the average ranking computed for SM 33 and the corresponding percentage of students that agreed the IM was effective for SM 22 – 31. Additionally, the Spearman's rho bivariate correlation coefficient between students' responses for SM 22 – 31 and their matched responses from SM 33 are reported. Ranking order and effectiveness perceptions for each IM showed significant positive correlations for 5 out of

10 IM. It is interesting that students ranked *studying in small groups* as most effective and *working through PBL* as 2nd most effective, although the relationships were not significant due to the spread of counts per rank over the most effective end of the scale for ranks 1 - 4. The opposite occurred for *engaging in discussion boards* where the spread of counts per rank over the least effective end of the scale encompassed ranks 8 – 10. As with TLM, this may be affected by students' interpretation of the term *effective*, and in future survey iterations, perhaps the term *preferred* IM for learning anatomy may elicit different responses.

Table 29

Instructional Methods Ranking

SM	Question	*M*	A%	r_S	*p*
33	Rank the methods for learning anatomy from most effective (1) to least effective (10).				
27	1. Studying in small groups	3.92	62	0.149	0.387
29	2. Working through PBL	3.94	89	0.116	0.500
24	3. Clinician based teaching	4.03	78	0.534**	0.001
23	4. Watching pre-recorded lectures/PPTs	4.28	64	0.364*	0.029
30	5. Preparing a presentation	5.31	78	0.221	0.194
28	6. Creating a final project	5.94	69	0.322	0.056
31	7. Watching presentations	6.22	58	0.410*	0.013
22	8. Writing case reflections	6.42	42	0.490**	0.002
25	9. Reading clinical journals	7.44	31	0.437**	0.008
26	10. Engaging in discussion boards	7.50	31	0.112	0.515

Note. M = mean rank score, A% = agree + somewhat agree.
*Correlation is significant at the 0.05 level (2-tailed). **Correlation is significant at the 0.01 level (2-tailed).

Learning on Cadavers

To see if gender exerted any effect on students' perception of learning on cadavers, a Kruskal-Wallis test was performed. No SM question response showed significant gender-bias (see Table 31).

Table 30

Independent-Samples Kruskal-Wallis Test of Gender Differences for Cadavers

Null Hypothesis	*p*	H_0 Decision
The distribution of The most effective way I learned was to get my hands in, feel for structures, and manipulate the specimens. is the same across categories of gender.	.257	Retain
The distribution of The most effective way I learned in cadaver laboratory was in small groups. is the same across categories of gender.	.879	Retain
The distribution of I feel more comfortable watching others demonstrate structures on cadavers than touching/dissecting them myself. is the same across categories of gender.	.094	Retain
The distribution of I feel that the cadaver laboratory is a daunting environment in which to learn. is the same across categories of gender.	.548	Retain
The distribution of I feel that I learned other things while in the cadaver laboratory. (e.g. natural variation, communication skills) is the same across categories of gender.	.303	Retain
The distribution of I feel that working with cadavers helped me to positively address the issue of death. is the same across categories of gender.	.476	Retain
The distribution of I feel that working with cadavers helped me to better relate to patients. is the same across categories of gender.	.549	Retain
The distribution of I feel that working with cadavers is unnecessary. is the same across categories of gender.	.353	Retain
The distribution of I feel that working with cadavers is a vital part of becoming a clinician. is the same across categories of gender.	.960	Retain

Null Hypothesis	p	H_0 Decision
The distribution of I found the amount of anatomy material I needed to learn is the same across categories of gender.	.646	Retain
The distribution of I found the anatomy resources provided by the school to be limited/insufficient. is the same across categories of gender.	.424	Retain
The distribution of I have problems learning anatomy because I don't see the point to it. is the same across categories of gender.	.883	Retain
The distribution of I have problems learning anatomy because the teaching styles do not suit me. is the same across categories of gender.	.598	Retain
The distribution of My main motivation for learning anatomy is to pass exams and pass the course. is the same across categories of gender.	.270	Retain
The distribution of I find learning anatomy difficult because it is memorization based. is the same across categories of gender.	.304	Retain
The distribution of I feel course assessments do not reflect the learning that occurs. is the same across categories of gender.	.676	Retain

Within Cluster 2 (see Table 31), students reported high levels of agreement for cadavers as effective learning materials (SM 34 = 83%; SM 38 = 53%) and preferred to study in small groups (SM 35 = 75%). The majority of students disagreed (80%) that the cadaver lab was a daunting learning environment. Despite students' strong agreement and perception of cadavers as *vital* and *necessary*, only 31% agreed with SM 40 *I feel that working with cadavers helped me to better relate to patients,* and 42% agreed with SM 39 *I feel that working with cadavers helped me to positively address the issue of death.* Historically, it is argued that cadavers are students' first patients cadavers assist students to deal with death, and that working with cadavers is a vital and necessary rite of passage for clinical trainees (Brenton et al., 2007; Older, 2004; Shaffer, 2004; Sugand et al., 2010). Further study questions could be posed in focus group format to deeply understand this disconnect, and to elucidate reasons why students do not view cadavers as a bridge to patients.

Table 31

ALE Cluster 2: Learning on Cadavers

			Response %			Likert 1-5	
ALE	SM	Question	A	N	D	*M*	*SD*
8	34	The most effective way I learned was to get my hands in, feel for structures, and manipulate the specimens.	83	6	11	2.03	1.06
9	35	The most effective way I learned in cadaver laboratory was in small groups.	75	11	14	1.97	1.21
	36	I feel more comfortable watching others demonstrate structures on cadavers than touching/dissecting them myself.	39	17	44	3.19	1.62
10	37	I feel that the cadaver laboratory is a daunting environment in which to learn.	3	17	80	4.25	0.84
11	38	I feel that I learned other things while in the cadaver laboratory. (e.g. natural variation, communication skills)	53	28	19	2.47	1.25
12	39	I feel that working with cadavers helped me to positively address the issue of death.	42	25	33	2.94	1.37
	40	I feel that working with cadavers helped me to better relate to patients.	31	22	47	3.25	1.42
	41	I feel that working with cadavers is unnecessary.	20	11	69	3.78	1.22
29	42	I feel that working with cadavers is a vital part of becoming a clinician.	69	17	14	2.14	1.18

SM 42 *I feel that working with cadavers is a vital part of becoming a clinician,* showed a strong inverse (negative) Spearman's rho correlation with SM 41 *I feel that working with cadavers is unnecessary* (see Table 32). This finding provides evidence of

reliability for students' congruent responses to both a positively and a negatively worded question on the same theme.

Table 32

Spearman's rho Correlation for SM 41 and SM 42

		I feel that working with cadavers is a vital part of becoming a clinician.	I feel that working with cadavers is unnecessary.
I feel that working with cadavers is a vital part of becoming a clinician.	r_s	1.000	-0.849**
	p		0.000
	N	36	36
I feel that working with cadavers is unnecessary.	r_s	-0.849**	1.000
	p	0.000	
	N	36	36

** Correlation is significant at the 0.01 level (2-tailed).

Just as students reported their perception of the cadaver lab as not daunting in which to learn, they also reported their perception of the amount of material to learn as not daunting (see Table 33). The majority of students (81%) perceived the amount of material as *appropriate and manageable*. This finding instills confidence that the course director exercised good judgment for content inclusion during the design and development phases.

Table 33

ALE Cluster 3a: Learning Problems

ALE	SM	Question	Response %
13	43	I found the amount of anatomy material I needed to learn	
		• Minimal and unchallenging	3
		• Appropriate and manageable	81
		• Daunting and challenging	11
		• Overwhelming and excessive	6

Student Open Responses (n = 11)

Previous anatomy experience has made studying easier, but material otherwise would have been challenging.

While I enjoyed learning anatomy, I feel that what was taught in lecture and cadaver lab did not reflect what was included on the lab lists.

Not always but it's a lot of volume.

Lots of material, but expectations were clearly communicated. Probably the best of any class last semester.

There was a lot of material.

It was a lot of material, but I think that it is appropriate for our future profession.

I tried to memorize too much detail initially but was able to better direct my efforts after the first exam.

It was helpful to have taken anatomy in undergrad prior to coming to the AA program.

Too many objectives are listed, causing it to become overwhelming. More emphasis should be placed on objectives that relate most to anesthesia. But having over a 12 page filled out objective list for each system is overwhelming and excessive.. at that point you just learn for the test and forget it the next day.

The amount that we actually needed to learn was certainly appropriate and manageable. However, sometimes I would get overwhelmed when I was confused how much I "really needed to know" for the class and the vast expanse of human anatomy beyond that point.

The lab lists really helped!

Learning Problems

All students (100%) disagreed with SM 45 *I have problems learning anatomy because I don't see the point to it* (see Table 34). This finding is consistent with positively worded questions where students agreed anatomy is important to becoming a clinician. Thus, students perceive anatomy as relevant to AAs, which demonstrates the course director/IDer has accomplished the EUAAP administrators' goal of explicating correlations between anatomy and clinical practice. The redesigned course ANES 525 has matched is name: Applied Anatomy for Anesthesia Practice.

Most students (63%) disagreed with SM 46 *I have problems learning anatomy because the teaching styles do not suit me*. This finding suggests students like the pedagogy and instructional methods, which demonstrates the course director/IDer has accomplished the EUAAP administrators' goal of selecting effective progressive medical education pedagogies that are accepted by students. Also, I attribute this success to the teaching abilities of the instructor and perceptive abilities of the course director/IDer to: (a) deeply analyze the target population; (b) discern how AA students could best learn anatomy; (c) anticipate how they would like to learn anatomy; and (d) choose best-practice pedagogy, TLM, and IM germane to AAs from the literature. Additionally, most students (67%) reported that assessments reflect learning, which supports the findings of significantly increased posttest scores compared to pretest scores as indicative of learning.

Table 34

ALE Cluster 3b: Learning Problems

			Response %			Likert 1-5	
ALE	SM	Question	A	N	D	*M*	*SD*
14	44	I found the anatomy resources provided by the school to be limited/insufficient.	39	14	47	3.25	1.36
15	45	I have problems learning anatomy because I don't see the point to it.	0	0	100	4.83	0.38
16	46	I have problems learning anatomy because the teaching styles do not suit me.	20	17	63	3.75	1.25
18	47	My main motivation for learning anatomy is to pass exams and pass the course.	28	11	61	3.61	1.25
19	48	I find learning anatomy difficult because it is memorization based.	25	14	61	3.78	1.38
17	49	I feel course assessments do not reflect the learning that occurs.	11	22	67	3.97	1.06

Student Open Responses (*n* = 5)

More allocated time for our group to be in the cadaver lab.

I found the extra anatomy videos on YouTube to be extra helpful for reviewing the topics.

Powerpoint presentations would have been nice, even if not presented in class. I did like the lab lists and scales though.

I would not have done well in the class with just the material on blackboard. However, I don't think it is the instructor's responsibility to provide everything. It is the responsibility of the student to use whatever resources will help, which includes looking up things on our own.

There were many online textbooks, models, etc. However the online textbooks were sometimes annoying due to the fact that they would mostly go by sections of the body, whereas we would go by body systems. So it was sometimes difficult the relevant information in the online textbooks.

Assessment Method Rankings

Per the revised grading scale, written examinations comprised 50% of the course grade. As such, students' ranking of *written examinations* as the assessment method most representative of their learning is in alignment with usual and customary student perceptions within the context of grades as drivers and motivators for student engagement and achievement (see Table 35). SCALEs included PBL, f2f small group discussion, experiential, authentic, and clinically applied learning exercises. It is encouraging to discover students' perception of *SCALEs* as highly representative of their learning.

Table 35

Assessment Methods Ranking

ALE	SM	Question	Rating Ave
	50	Rank the assessment methods from most effective (1) to least effective (6) representation of your learning.	
		1. Written examinations	2.19
		2. SCALEs	2.42
		3. Attendance/participation	3.81
		4. Case reflections	3.86
		5. Final projects	4.00
		6. Discussion posts	4.72

Using Anatomy Knowledge

Independent samples Kruskal-Wallis test of Likert-type survey questions SM 51 – 61 and gender showed no significant relationships of gender bias, with two exceptions (see Table 36). SM 52 *I have problems using my anatomy knowledge because I am not confident in my knowledge base*, and SM 54 *I find that I am using anatomical terms and language frequently in clinical situations*, showed a female dominant response (p = 0.032 and 0.046 respectively). Thus, the null hypotheses were rejected. SM 52 aligns with ALE 22, which also showed a female dominant bias in the study by Smith et al. (2013). SM 54 aligns with ALE 24, but Smith et al. (2013) did not find a significant gender bias.

Table 36

Independent-Samples Kruskal-Wallis Test of Gender Differences

Null Hypothesis	*p*	H_0 Decision
The distribution of I feel the course allows me to quickly use my anatomy knowledge. is the same across categories of gender.	.810	Retain
The distribution of I have problems using my anatomy knowledge because I am not confident in my knowledge base. is the same across categories of gender.[a]	.032*	Reject
The distribution of I find that my anatomy learning serves as a basis other subject learning. is the same across categories of gender.	.523	Retain
The distribution of I find that I am using anatomical terms and language frequently in clinical situations. is the same across categories of gender.[b]	.046*	Reject
The distribution of I find that I am using my anatomy medical imaging knowledge frequently in clinical situations. is the same across categories of gender.	.935	Retain
The distribution of I find that I am using my living (surface) anatomy knowledge frequently in clinical situations. is the same across categories of gender.	.121	Retain
The distribution of Because of the specialty I am studying (anesthesiology), I feel anatomy is of low importance to me. is the same across categories of gender.	.869	Retain
The distribution of I feel that I will become part of the medical profession once I can fully communicate in medical (anatomical) language. is the same across categories of gender.	.307	Retain
The distribution of I feel that understanding anatomy is a very important part of becoming an AA. is the same across categories of gender.	.259	Retain
The distribution of I feel that working with cadavers and cadaveric specimens is an important pat of becoming an AA. is the same across categories of gender.	.252	Retain
The distribution of My opinion of anatomy's clinical relevance increased as the course progressed. is the same across categories of gender.	.958	Retain

Note. [a]SM 52 corresponds to ALE 22, where Smith et al. (2013) reported a female gender bias. [b]SM 54 corresponds to ALE 24, which did not show a gender bias (Smith et al., 2013).
* Correlation is significant at the 0.05 level (2-tailed).

Table 37 shows the frequency of responses per category for gender. One possible explanation is the small sample size for this study of males (n = 19) and females (n = 17) as compared to Smith et al., (2013) which had a higher number of male (n = 117) and female (n = 110) subjects.

Table 37

SM 52 and 54 Gender Crosstabulations

		Gender		
Question	Response	Female	Male	Total
SM 52: I have problems using my anatomy knowledge because I am not confident in my knowledge base.	Agree	0	0	0
	Somewhat Agree	5	1	6
	Unsure/Neutral	4	4	8
	Somewhat Disagree	6	7	13
	Disagree	2	7	9
	Total	17	19	36
SM 54: I find that I am using anatomical terms and language frequently in clinical situations.	Agree	11	7	18
	Somewhat Agree	6	8	14
	Unsure/Neutral	0	2	2
	Somewhat Disagree	0	1	1
	Disagree	0	1	1
	Total	17	19	36

Table 38 provides insight as to how students use anatomy knowledge and skills. All questions showed positive attitudes about knowledge, skills, and learning because at least 50% of students agreed or disagreed respectively.

Table 38

ALE Cluster 4: Using Anatomy

			Response %			Likert 1-5	
ALE	SM	Question	A	N	D	*M*	*SD*
21	51	I feel the course allows me to quickly use my anatomy knowledge.	83	11	6	1.86	0.83
22[a]	52[b]	I have problems using my anatomy knowledge because I am not confident in my knowledge base.	17	22	51	3.69	1.04
23	53	I find that my anatomy learning serves as a basis other subject learning.	84	3	3	1.50	0.70
24	54[b]	I find that I am using anatomical terms and language frequently in clinical situations.	89	6	5	1.69	0.92
25	55	I find that I am using my anatomy medical imaging knowledge frequently in clinical situations.	50	11	39	2.68	1.42
26	56	I find that I am using my living (surface) anatomy knowledge frequently in clinical situations.	86	3	11	1.78	1.05

Note. [a] ALE question with a significant female gender bias (Smith et al., 2013).
[b]SM questions with a significant female gender bias (see Table 3).

Of note, questions SM 1 – 12, 32, 33, 50, and 62 were not tested for gender bias due to the question type or topic of interest.

Overall Perceptions

SM 57 *Because of the specialty I am studying (anesthesiology), I feel anatomy is of low importance to me* showed a strong inverse (negative) Spearman's rho correlation with SM 59 *I feel that understanding anatomy is a very important part of becoming an AA* (see Table 39). This finding provides evidence of reliability for students' congruent responses to both a positively and a negatively worded question on the same theme.

Table 39

Spearman's rho Correlation for SM 57 and SM 59

		SM 57: Because of the specialty I am studying (anesthesiology), I feel anatomy is of low importance to me.	SM 59: I feel that understanding anatomy is a very important part of becoming an AA.
SM 57: Because of the specialty I am studying (anesthesiology), I feel anatomy is of low importance to me.	r_S	1.000	-0.503**
	p		0.002
	N	36	36
SM 59: I feel that understanding anatomy is a very important part of becoming an AA.	r_S	-0.503**	1.000
	p	0.000	
	N	36	36

** Correlation is significant at the 0.01 level (2-tailed).

SM 42 *I feel that working with cadavers is a vital part of becoming a clinician* showed a strong positive Spearman's rho correlation with SM 60 *I feel that working with cadavers and cadaveric specimens is a very important part of becoming an AA* (see Table 40). This finding provides evidence of reliability for students' congruent responses to analogously worded questions on the same theme of cadavers, even though the SM 42 and SM 60 were 18 questions apart.

Table 40

Spearman's rho Correlation for SM 42 and SM 60

		SM 42: I feel that working with cadavers is a vital part of becoming a clinician.	SM 60: I feel that working with cadavers and cadaveric specimens is an important part of becoming an AA.
SM 42: I feel that working with cadavers is a vital part of becoming a clinician.	*rS*	1.000	0.601**
	p		0.000
	N	36	36
SM 60: I feel that working with cadavers and cadaveric specimens is an important part of becoming an AA.	r_S	0.601**	1.000
	p	0.000	
	N	36	36

** Correlation is significant at the 0.01 level (2-tailed).

Additionally, students disagreed with SM 57 (92%) and agreed with SM 59 (97%) in similar, high proportions, thus demonstrating a high level of confidence and conviction in their perception of the value of anatomy as a course for AAs (see Table 41). Students agreed with SM 42 (69%; see Table 31) and SM 60 (58%; see Table 41) in similar, high proportions, thus demonstrating a high level of confidence and conviction in their perception of the value of cadavers as a TLM and dissection/prosection as an IM in an anatomy course for AAs.

Table 41

ALE Cluster 5: Overall Perceptions of Anatomy

			Response %			Likert 1-5	
ALE	SM	Question	A	N	D	*M*	*SD*
31	57	Because of the specialty I am studying (anesthesiology), I feel anatomy is of low importance to me.	8	0	92	4.42	0.97
27	58	I feel that I will become part of the medical profession once I can fully communicate in medical (anatomical) language.	72	17	11	2.08	0.98
28	59	I feel that understanding anatomy is a very important part of becoming an AA.	97	3	0	1.22	0.49
29	60	I feel that working with cadavers and cadaveric specimens is an important pat of becoming an AA.	58	14	28	2.53	1.30
30	61	My opinion of anatomy's clinical relevance increased as the course progressed.	86	8	6	1.89	0.89

These two results could be presented as evidence to stakeholders who may suggest eliminating cadavers or the anatomy course from the EUAPP curriculum, and could inform other AA program stakeholders who may be considering similar curricular changes. Of course, these results must be weighed against the students' overall perception and ranking of cadavers as 7th most effective TLM (out of 9). Even so, I would argue to stakeholders that students should be afforded the learning opportunity to utilize cadavers as a TLM in ANES 525 on a political basis for maintaining associations within the EUSOM, highly coveted cadaver lab access, and a locus of power within the EUAAP. Furthermore, Table 41 shows students perceive high overall values for anatomy to anesthesiology, AA profession, communication, and clinical practice.

Table 42 provides insight to students' thoughts, concerns, suggestions, and comments. Some are helpful, some reinforce my thoughts, and others create doubt and opportunities to further explore the instructional strategies of ANES 525.

Table 42

Open Response

ALE	SM	Question
	62	Please provide any comments or suggestions for this study.

Lab Objectives were very helpful!

I found final projects to be my favorite part of this course, I do wish that they were a weekly part of class.

I enjoyed how the anatomy course was taught. I'm not sure if it would be effective for other courses though. I think anatomy is heavy on memorization and this way of teaching could apply perfectly to other subjects with the same emphasis, but subjects that are heavier on concepts and manipulation of material would be harder to apply.

Definitely more structure-based learning would be nice, ie power point presentations and some formal lectures. I REALLY enjoyed the cadaver labs when small groups were allowed to ask Sally all the questions we had. Sally is an excellent teacher in small groups because she is very passionate and engaging.

The anatomy class should in some way be more geared towards anesthesia.. Learning the vasculature was extremely helpful, but there are some other systems where i feel as though we went into too much detail.

Some of the material we learned didn't seem like it needed to be covered as in depth as it was...such as GI/GU, detailed brain anatomy, histology, etc.

The cadaver's provided little application to anesthesia due to the dead tissue. Having already taken a cadaver course to get into the class, it did not seem useful. Everything else focused better on what we were doing and how anatomy could be focused on anesthesia

Conclusions

This study has documented student academic achievement and student perceptions of ANES 525 Applied Anatomy for Anesthesia Practice. The previously stated course goals and aims can serve as a summative assessment of IDer, course director, and instructor compliance and effectiveness, while student academic achievement (QUAN) and perceptions of the course (QUAL) support the claims. Supporting items are referenced by question number (i.e., SM #), Table or Figure number, section heading, or short explanation.

The goals for redesign of BAHS 500 Human Anatomy with Cadaver Laboratory as set by EUAAP administrators were to:

A. Decrease credit hours from 3 to 2;
   - Students were allotted 5 hr/wk out of class to acquire basic content knowledge via the LMS learning modules and self-directed study in order to prepare for instructor-facilitated, student-centered applied learning f2f classroom at 5 hr/wk. The course met f2f for labs, small group activities, discussions, and student presentations over the 15 week semester. Each week, students participated in a 3 hr session Tuesday morning or Tuesday afternoon with an approximate 18:1 student-teacher ratio, and a 2 hr session Thursday afternoon at 37:1. Table 33, SM 43

B. Decrease cost and time constraints associated with dissection by eliminating cadaver laboratory;
   - See Chapter 4 discussion on flipped classroom and blended learning for best use of in-class time.

C. Utilize progressive medical education pedagogy;
   - Instructional frameworks: flipped classroom, blended learning, Brain Targeted Teaching Model. See Chapter 4 discussion of flipped, blended, and BTT classrooms. SM 46

- Assessments aligned with objectives and reflective of learning. See Chapter 4 for instructional strategies that include assessments. Tables 11-16, SM 49

D. Increase use of technology and medical images; and

- Learning modules were made available to students online via the EU supported learning management system (LMS) Blackboard Learn 9.1 SP14. Principal course resources comprising each systems-based learning module were lab lists, readings, images, videos, and assignments.
- Medical technologic equipment utilized was ultrasound, video-laryngoscope, CT/MRI software, and electronic medical record (EMR).
- Table 24, Table 26, Table 27, Table 38, Table 41, SM 23, SM 55

E. Incorporate clinical content of applied anatomy relevant to anesthesia practice.

- Accomplished through completion of assignments, such as, SCALEs, case reflections, and projects.
- Use of medical equipment, software, instruments, and products.
- Table 24, Table 26, Table 27, Table 38, Table 41, SM 23, SM 55

ANES 525 Applied Anatomy for Anesthesia Practice aimed to:

A. Make the student appreciate the importance of anatomy to the practice of anesthesiology;

- Table 38, Table 41, SM 45, SM 47

B. Help the student develop clinical skills (cognitive, psychomotor, affective, and communication) required of anesthesia providers;

- Table 38, Table 41, SM 38, SM 40, SM 42

C. Develop the ability of the student to transfer acquired knowledge and skills to subsequent courses and the clinical environment; and
   - Table 38, Table 41

D. Develop schema for lifelong learning.
   - Students supplemented LMS content with resources of their choosing. SM 18
   - Write case reflections, create a final project, read clinical journals, prepare a presentation, work through PBL. See Chapter 4 identification of authentic activities.

Researcher Biases

There are several possible entry points for bias within this study design of an applied dissertation. For instance, the SI was inherently a JHU SOE degree-seeking doctoral student; motivation to finish the study, defend, and graduate were paramount, and although I can not recognize a distinct instance, that is exactly the point of subconscious bias included in every decision throughout the three year study. The SI was also the ANES 525 course director and instructor; daily instructional interactions with students and instructor-student relationships likely influenced the SI's attitude and behavior so as to affect dose, adherence, and quality of intervention implementation. Subsequently, the students' reported their perceptions of the TLM and IM, which could have been influenced by the instructor's attitude and behavior, and which were a direct indicator of responsiveness. Another form of bias concerning quality of intervention design could have resulted from the SI functioning as the instructional designer. The IDer's because Perception of quality and operational definitions were that of the SI, who then transferred those ideals to the IDer, and whose knowledge, skills, and behavior resulted in the products (i.e., course design of ANES 525).

Also inherent in this study design was the SI performing the role of the evaluator. The ability of an individual to accurately, rigorously, and retrospectively evaluate his or her own intervention, implementation, and results is generally accepted as improbable. In real-world study designs, the researchers and evaluator are two different individuals or teams. Of course, the educational exercise of program evaluation was an intentional, integral part of the applied dissertation assignment. The SI recognizes the bias caused by 20/20 hindsight. Bias is a general limitation of this study, but there are additional specific limitations that need to be discussed further.

Limitations of the Study

Given the copious in-class time afforded to student-student and student-instructor interactions, further emphasis of online discussions via Blackboard were not instigated or assigned by the instructor. Rather, the instructor chose to facilitate one online discussion at the beginning of the semester. Although all students made an initial post, only eight students engaged in three or more replies. The instructor then chose to observe the organic instances of student-generated discussions ($n = 0$). Unfortunately, the CoP, named *The Anesthesia Lounge,* did not come to fruition, and OCL did not occur. This may be in part because in addition to anatomy f2f time, the students spent at least ten hours per week in other f2f courses, four hours per week in f2f labs, and two hours per week in f2f small group discussions. Additionally, students were assigned joint clinical rotations of up to 18 hours per week, and then informal time (i.e., lunch breaks and student initiated weekend study groups) contributed also. I suspect that due to the amount of time students spent f2f with each other, they did not find online discourse necessary. Any question or comment could likely have been made in person or in a group. These suppositions are supported by evidence of the students' perception and rating of low effectiveness for the online discussion board. Students ranked the discussion board as the least effective instructional method (see Table 27) and the least effective assessment method (see Table 35). Although the instructor did not forcefully implement OCL and online discourse, I think that it may have drawn similar low effectiveness ratings if it was contrived and false. Perhaps it could have been an effective instructional strategy if the EUAAP curriculum did not involve copious opportunities for in-person dialogue.

The ANES 525 course goal, *develop the ability of the student to transfer acquired knowledge and skills to the clinical environment,* was only measured as a self-reported (e.g., students' perceptions) short-term outcome (e.g., one semester of clinical rotations, average 175 hours). Occasional verbal self-reports were made to the instructor where students testified having applied course topics during clinical rotations. Unfortunately, the instructor did not document the statements. Also, formative and summative clinical assessments for transfer of knowledge and skills were not possible within the time constraints and manpower hours allotted to this study. However, it may be possible to administer a survey to the 2015 cohort as second-year students at longitudinal intervals of one year and 1.5 years post-course completion. This may provide a deeper understanding of how students transfer ANES 525 knowledge and skills to the clinical setting.

Future Recommendations

The study results will inform future iterations of ANES 525 course design, development, and implementation at EUAAP. For example, inclusion of virtual cadaver technology/lab fee may be possible, and/or open-courseware may become available at no cost. Alternatively, purchasing plastic models and plastinated specimens may be considered better use of funds given that 100% of students perceived plastic models as effective TLM. Additionally, multiple cohorts can use these two types of tangible, reusable TLM year-to-year as opposed to recurring virtual cadaver per-student, per-year access fees. This would be my recommendation to EUAAP administrators and stakeholders.

Perhaps in future iterations of the EUAAP curriculum, decreased in-class time may be the driver for implementation of substantial online discourse, but for now, first-year students are accustomed to spending afternoons Monday – Friday, 13:00 – 17:00 in f2f classes. If there should be program-wide curricular changes to adopt the flipped classroom framework for other courses, or to engage second-year students who only attend f2f sessions bimonthly, then implementation of online discussions within an Online Collaborative Learning model and Community of Inquiry model would be my recommendation to EUAAP administrators and stakeholders (T. Anderson & Elloumi, 2004; Garrison et al., 1999; Harasim, 2011; Keegan, 2013; Porter et al., 2014; Vaughan, 2007).

In future iterations of the grading scale, SCALEs may be granted a higher weight so as to eclipse written examinations in both actual and perceived importance. It may be possible to devise alternative written examination that include question types other than MCQ single best answer and matching of given terms, which would be more representative of the critical thinking and free-text type answers required for SCALE deliverables. Despite evidence-based studies in BTT and collaborative learning literature, it is very unlikely that MCQs will be eliminated as an assessment method for two reasons: (a) to qualify as a certified anesthesiologist assistant, candidates must pass the national certification examination comprised of MCQs as the gold standard of medical knowledge assessment; and (b) the EUAAP prepares students for the national examination by requiring students pass a series of 18 comprehensive examinations (CEs) in MCQ format. CEs and question banks are maintained in LXR testing software database that enables automatic scoring and provides test statistics to instructors. On the contrary, incorporation of free-text answer questions is not compatible with LXR, would require greater time input by the instructor for grading, and would not be in alignment with the EUAAP and national exam formats.

It is possible that other AA program administrators, course directors, instructional designers, instructors, and stakeholders may find the study results applicable to their local context of AA education. Additionally, this study may contribute to the broader fields of medical education, allied health professions education, nursing education, clinical training, and simulation in healthcare. The ultimate intention is to increase educator knowledge of a deeper understanding of student perceptions so as to provide the most effective instructional strategies and learning opportunities for students.

Appendix A

Course Schedule BAHS 500 Fall 2013

Adapted from “BAHS 500 Basic Allied Health Sciences, Human Anatomy with Cadaver Laboratory, Course Schedule Fall 2013” by E. Pettus and S. A. Mitchell. 2013. Emory University School of Medicine and Emory AA Program. Unpublished.

Date	Time	Room	Lec #	Lecture Title/Laboratory	Text Chapters	Lecturer
					Marieb DesJardins M&M	
Tue 9/3	1:00-2:00	EP	Lec 01	Peer Learning, Introduction		Mitchell
	2:00-3:00	EP	Lec 02	Cells, Tissue (bone, cartilage, muscle)	1, 4, 6, 10	Mitchell
	3:00-5:00	EP		LAB 01 - Cells, Tissue (bone, cartilage, muscle)		
Fri 9/6	9:00-12:00	SOM		LAB 02 - Skeletal - Axial, Skull		
	1:00-2:00	190	Lec 03	Skeletal - Axial, Skull	7	Mitchell
	2:00-3:00	190	Lec 04	Orientation to Lab		Abelew
	3:00-5:00			LAB - Peer Learning		
Tue 9/10	9:00-12:00	SOM		LAB 03 - Tissue (neuro), Integument, Skeletal		
	1:00-2:00	190	Lec 05	Tissue (neuro), Integument, PNS named	4, 12, 5, 14	Mitchell
	2:00-3:00	190	Lec 06	Skeletal - Axial, Vertebrae	7	Mitchell
	3:00-5:00			LAB - Peer Learning		
Fri 9/13	9:00-12:00	SOM B16		**** med students in lab 10a-12p****	Skeletal System - Appendicular, Joints	
	1:00-2:00	190	Lec 07	Skeletal System - Appendicular	8	Lewis
	2:00-3:00	190	Lec 08	Skeletal System - Joints	9	Lewis
	3:00-5:00			LAB - Peer Learning		
Mon 9/16	8:00-3:00	FYI	****	lab closed for PA exam	no AA students allowed in la	*****
Tue 9/17	9:00-12:00	SOM		LAB 05 - Muscles		
	1:00-2:00	190	Lec 09	Muscles - Axial	11, 1-12	Lewis
	2:00-3:00	190	Lec 10	Muscles - Appendicular	11	Lewis
	3:00-5:00			LAB - Peer Learning		
Fri 9/20	9:00-12:00	SOM		LAB 06 - Muscles		
	1:00-2:00	190	Lec 11	PNS - Cranial nerves in periphery (not	14	Pettus
	2:00-3:00	190	Lec 12	ANS	15	Pettus
	3:00-5:00			LAB - Peer Learning		
Tue 9/24	9:00-12:00	SOM		LAB 07 - PNS		
	1:00-2:00	130	Lec 13	Clinical - Face, Skull, Head (with gen PA class)		Mitchell
	2:00-3:00	190	Lec 14	Review		Lewis
	3:00-5:00			LAB - Peer Learning		Mitchell
Fri 9/27	8:00-12:00	SOM	****	lab closed for exam setup *****		*****
	12:00-1:00	B16	group A	non-clinical & non-sim students	LAB EXAM 1 (Labs 1-7)	
	1:00-2:00	B16	group B	clinical & sim students	LAB EXAM 1	
	3:00-4:00	EP		all students	LECTURE EXAM 1 (Lec 1-14)	

Date	Time	Room	Lec #	Lecture Title/Laboratory	Text Chapters	Lecturer
					Marieb DesJardins M&M	
Tue 9/3	1:00-2:00	EP	Lec 01	Peer Learning, Introduction		Mitchell
	2:00-3:00	EP	Lec 02	Cells, Tissue (bone, cartilage, muscle)	1, 4, 6, 10	Mitchell
	3:00-5:00	EP		LAB 01 - Cells, Tissue (bone, cartilage, muscle)		
Fri 9/6	9:00-12:00	SOM		LAB 02 - Skeletal - Axial, Skull		
	1:00-2:00	190	Lec 03	Skeletal - Axial, Skull	7	Mitchell
	2:00-3:00	190	Lec 04	Orientation to Lab		Abelew
	3:00-5:00			LAB - Peer Learning		
Tue 9/10	9:00-12:00	SOM		LAB 03 - Tissue (neuro), Integument, Skeletal		
	1:00-2:00	190	Lec 05	Tissue (neuro), Integument, PNS named	4, 12, 5, 14	Mitchell
	2:00-3:00	190	Lec 06	Skeletal - Axial, Vertebrae	7	Mitchell
	3:00-5:00			LAB - Peer Learning		
		SOM				
Fri 9/13	9:00-12:00	B16		**** med students in lab 10a-12p****	Skeletal System - Appendicular, Joints	
	1:00-2:00	190	Lec 07	Skeletal System - Appendicular	8	Lewis
	2:00-3:00	190	Lec 08	Skeletal System - Joints	9	Lewis
	3:00-5:00			LAB - Peer Learning		
Mon 9/16	8:00-3:00	FYI	****	lab closed for PA exam	no AA students allowed in la	*****
Tue 9/17	9:00-12:00	SOM		LAB 05 - Muscles		
	1:00-2:00	190	Lec 09	Muscles - Axial	11, 1-12	Lewis
	2:00-3:00	190	Lec 10	Muscles - Appendicular	11	Lewis
	3:00-5:00			LAB - Peer Learning		
Fri 9/20	9:00-12:00	SOM		LAB 06 - Muscles		
	1:00-2:00	190	Lec 11	PNS - Cranial nerves in periphery (not	14	Pettus
	2:00-3:00	190	Lec 12	ANS	15	Pettus
	3:00-5:00			LAB - Peer Learning		
Tue 9/24	9:00-12:00	SOM		LAB 07 - PNS		
	1:00-2:00	130	Lec 13	Clinical - Face, Skull, Head (with gen PA class)		Mitchell
	2:00-3:00	190	Lec 14	Review		Lewis
	3:00-5:00			LAB - Peer Learning		Mitchell
Fri 9/27	8:00-12:00	SOM	****	lab closed for exam setup *****		*****
	12:00-1:00	B16	group A	non-clinical & non-sim students	LAB EXAM 1 (Labs 1-7)	
	1:00-2:00	B16	group B	clinical & sim students	LAB EXAM 1	
	3:00-4:00	EP		all students	LECTURE EXAM 1 (Lec 1-14)	

Date	Time	Room	Lec #	Lecture Title/Laboratory	Text Chapters	Lecturer
					Marieb DesJardins M&M	
Tue 9/3	1:00-2:00	EP	Lec 01	Peer Learning, Introduction		Mitchell
	2:00-3:00	EP	Lec 02	Cells, Tissue (bone, cartilage, muscle)	1, 4, 6, 10	Mitchell
	3:00-5:00	EP		LAB 01 - Cells, Tissue (bone, cartilage, muscle)		
Fri 9/6	9:00-12:00	SOM		LAB 02 - Skeletal - Axial, Skull		
	1:00-2:00	190	Lec 03	Skeletal - Axial, Skull	7	Mitchell
	2:00-3:00	190	Lec 04	Orientation to Lab		Abelew
	3:00-5:00			LAB - Peer Learning		
Tue 9/10	9:00-12:00	SOM		LAB 03 - Tissue (neuro), Integument, Skeletal		
	1:00-2:00	190	Lec 05	Tissue (neuro), Integument, PNS named	4, 12, 5, 14	Mitchell
	2:00-3:00	190	Lec 06	Skeletal - Axial, Vertebrae	7	Mitchell
	3:00-5:00			LAB - Peer Learning		
Fri 9/13	9:00-12:00	SOM B16		**** med students in lab 10a-12p****	Skeletal System - Appendicular, Joints	
	1:00-2:00	190	Lec 07	Skeletal System - Appendicular	8	Lewis
	2:00-3:00	190	Lec 08	Skeletal System - Joints	9	Lewis
	3:00-5:00			LAB - Peer Learning		
Mon 9/16	8:00-3:00	FYI	****	lab closed for PA exam	no AA students allowed in la	*****
Tue 9/17	9:00-12:00	SOM		LAB 05 - Muscles		
	1:00-2:00	190	Lec 09	Muscles - Axial	11, 1-12	Lewis
	2:00-3:00	190	Lec 10	Muscles - Appendicular	11	Lewis
	3:00-5:00			LAB - Peer Learning		
Fri 9/20	9:00-12:00	SOM		LAB 06 - Muscles		
	1:00-2:00	190	Lec 11	PNS - Cranial nerves in periphery (not	14	Pettus
	2:00-3:00	190	Lec 12	ANS	15	Pettus
	3:00-5:00			LAB - Peer Learning		
Tue 9/24	9:00-12:00	SOM		LAB 07 - PNS		
	1:00-2:00	130	Lec 13	Clinical - Face, Skull, Head (with gen PA class)		Mitchell
	2:00-3:00	190	Lec 14	Review		Lewis
	3:00-5:00			LAB - Peer Learning		Mitchell
Fri 9/27	8:00-12:00	SOM	****	lab closed for exam setup *****		*****
	12:00-1:00	B16	group A	non-clinical & non-sim students	LAB EXAM 1 (Labs 1-7)	
	1:00-2:00	B16	group B	clinical & sim students	LAB EXAM 1	
	3:00-4:00	EP		all students	LECTURE EXAM 1 (Lec 1-14)	

Appendix B

Stakeholder Analysis

Stakeholder (SH)	Sally Mitchell, MMSc	Sally Mitchell, MMSc
Role in Organization	Course Director (CD) and Instructor	Instructional Designer (IDer)
Stake or Interest in Program	Facilitate student learning and satisfaction	Design instruction to facilitate student learning
Stake or Interest in Evaluation	Receive formative feedback on instruction Receive summative feedback on ID product Provide formative feedback on ID product	Receive formative feedback on ID process and product Receive summative feedback on ID process and product Provide formative feedback on ID process and product
Needed from SH to Successfully Implement Program	Instruct students Adhere to ID Implement the intervention	Apply ID theory and models Design the course (ID product)
Needed from SH to Successfully Conduct Evaluation	Collect and record data Provide formative feedback on ID product	Collect and record data Provide formative feedback on ID process
Influence on Program Success	Total control	Total control
Influence on Evaluation Success	Total control	Only indirectly as a result of the ID product implementation
Potential Issues with SH	Noncompliance Ineffective instruction Turnover	Noncompliance Ineffective ID product Turnover
Relative Importance of SH	1 - PIU	1 - PIU

Stakeholder (SH)	Sally Mitchell, MMSc	Sally Mitchell, MMSc
Role in Organization	Process Champion	Analysis Facilitator
Stake or Interest in Program	As it pertains to the PC's daily job duties	As it pertains to the AF's daily job duties
Stake or Interest in Evaluation	Fulfill job duties as assigned by AA program directors Opportunity to assume a leadership role in the organization and exhibit leadership strengths	Fulfill job duties as assigned by AA program directors Opportunity to assume a leadership role in the organization and exhibit leadership strengths
Needed from SH to Successfully Implement Program	As it pertains to the PC's daily job duties	As it pertains to the AF's daily job duties
Needed from SH to Successfully Conduct Evaluation	Maintain credibility of evaluation process Organize program faculty/staff Assist with SH buy-in Lead evaluation team Provide programmatic insight to evaluator	Establish credibility of evaluation process Organize program faculty/staff Lead analysis team Provide programmatic insight to evaluator
Influence on Program Success	As it pertains to the PC's daily job duties	As it pertains to the AF's daily job duties
Influence on Evaluation Success	Compliance Cooperation Collaboration Work ethic Effectiveness of leadership	Compliance Cooperation Collaboration Work ethic Effectiveness of leadership
Potential Issues with SH	Noncompliance Obstructionist Turnover Ineffective leader Personal vs altruistic motivation	Noncompliance Obstructionist Turnover Ineffective leader Personal vs altruistic motivation
Relative Importance of SH	2	2

Stakeholder (SH)	Richard Brouillard, MMSc, ScD	Richard Brouillard, MMSc, ScD
Role in Organization	Anesthesiologist Assistant Program Director Evaluation Sponsor	Executive Sponsor for POP
Stake or Interest in Program	Quality control of AA program curriculum, courses, instruction Support faculty efforts to foster student learning and satisfaction Support CD efforts in professional development	Quality control of AA program curriculum, courses, instruction Support JHU student efforts to foster student learning and satisfaction Support PD of JHU student through cognitive apprenticeship
Stake or Interest in Evaluation	Formative and summative curriculum and course decision-making AA program reputation AA program accreditation	Formative and summative curriculum and course decision-making Support PD of JHU student as an AA program faculty member
Needed from SH to Successfully Implement Program	Support CD	Support JHU student
Needed from SH to Successfully Conduct Evaluation	Endorse and support analysis and eval teams Grant evaluator access to data Assist with SH buy-in	Support JHU student
Influence on Program Success	Affects attitudes and beliefs of SHs	Support JHU student Provide continual formative feedback on ID process/progress
Influence on Evaluation Success	Grants permission to access data Determines usage of eval results	Support JHU student Provide continual formative feedback on eval process/progress
Potential Issues with SH	Noncompliance Obstructionist Turnover	Fails to provide adequate support
Relative Importance of SH	3	3

Stakeholder (SH)	Edward Pettus, PhD	Edward Pettus, PhD
Role in Organization	Previous CD for AA human anatomy Emory Univ SOM faculty	Previous CD for AA human anatomy Emory Univ SOM faculty
Stake or Interest in Program	Quality control of SOM courses and instruction Support faculty efforts to foster student learning and satisfaction Support CD efforts in professional development	Quality control of AA program curriculum, courses, instruction Support faculty efforts to foster student learning and satisfaction Support CD efforts in professional development
Stake or Interest in Evaluation	Formative course decision-making Support PD of JHU student as an SOM program faculty member	Formative and summative curriculum and course decision-making AA program reputation AA program accreditation
Needed from SH to Successfully Implement Program	Support JHU student	Support CD
Needed from SH to Successfully Conduct Evaluation	Support JHU student	Endorse and support analysis and eval teams Assist with SH buy-in
Influence on Program Success	Support JHU student	Affects attitudes and beliefs of SHs
Influence on Evaluation Success	Support JHU student	Determines usage of eval results
Potential Issues with SH	Fails to provide adequate support	Noncompliance Obstructionist Turnover
Relative Importance of SH	4	3

Stakeholder (SH)	Katherine Monroe, MMSc, PhD	J. Ron Hall, MMSc, MD
Role in Organization	AA Associate Program Director	AA Program Medical Director
Stake or Interest in Program	Quality control of AA program curriculum, courses, instruction Support faculty efforts to foster student learning and satisfaction Support CD efforts in professional development	Quality control of AA program curriculum, courses, instruction Support faculty efforts to foster student learning and satisfaction Support CD efforts in professional development
Stake or Interest in Evaluation	Formative and summative curriculum and course decision-making AA program reputation AA program accreditation	Formative and summative curriculum and course decision-making AA program reputation AA program accreditation
Needed from SH to Successfully Implement Program	Support CD	Support CD
Needed from SH to Successfully Conduct Evaluation	Endorse and support analysis and eval teams Assist with SH buy-in	Endorse and support analysis and eval teams Grant evaluator access to data Assist with SH buy-in
Influence on Program Success	Affects attitudes and beliefs of SHs	Affects attitudes and beliefs of SHs
Influence on Evaluation Success	Determines usage of eval results	Grants permission to access data Determines usage of eval results
Potential Issues with SH	Noncompliance Obstructionist Turnover	Noncompliance Obstructionist Turnover
Relative Importance of SH	3	3

Stakeholder (SH)	Laureen Hill, MD, MBA	Emory Univ. AA Faculty and Staff
Role in Organization	Emory Univ. Dept of Anesthesiology Chair	Colleagues of CD
Stake or Interest in Program	Quality control of AA program curriculum, courses, instruction Graduation of competent AAs to join Emory Anesthesiology Dept work force	Quality control of AA program curriculum, courses, instruction Support faculty efforts to foster student learning and satisfaction Support CD efforts in professional development
Stake or Interest in Evaluation	AA program reputation AA program accreditation	Formative and summative curriculum and course decision-making AA program reputation AA program accreditation
Needed from SH to Successfully Implement Program	Support CD Assist with SH buy-in	Support CD Assist with SH buy-in
Needed from SH to Successfully Conduct Evaluation	Endorse analysis and eval teams	Endorse and support analysis and eval teams Grant evaluator access to data
Influence on Program Success	Support AA program	Support CD Formative feedback on ID process Collaboration to achieve AA program goals
Influence on Evaluation Success	Affects attitudes and beliefs of SHs	Compliance Cooperation Collaboration Affects attitudes and beliefs of SHs
Potential Issues with SH	Noncompliance Obstructionist Turnover Close AA program Terminate and appoint AA program faculty	Noncompliance Obstructionist Turnover
Relative Importance of SH	4	3

Stakeholder (SH)	Anesthesiologist Assistant Students
Role in Organization	Target population Participants Learners
Stake or Interest in Program	Quality of AA program curriculum, courses, instruction Opportunities to learn anatomy and anesthesiology Desire to be taught by effective instructor Expect value for tuition
Stake or Interest in Evaluation	Formative course assessment AA program reputation AA program accreditation Assurance of instructor effectiveness Assurance of course ID effectiveness
Needed from SH to Successfully Implement Program	Participation Positive attitude and behavior Flexibility, patience, and tolerance with novice CD and IDer
Needed from SH to Successfully Conduct Evaluation	Participation Positive attitude and behavior Flexibility, patience, and tolerance with novice evaluator, AF, and PC
Influence on Program Success	Participation Compliance Cooperation Collaboration
Influence on Evaluation Success	Participation Compliance Cooperation Collaboration
Potential Issues with SH	Noncompliance Obstructionist Refusal to participate in JHU study
Relative Importance of SH	4

Appendix C

ALE Questionnaire

Part 1. Your experiences of anatomy					
First cluster of questions asks about your learning.	Agree	Agree somewhat	Unsure	Disagree somewhat	Disagree
1. I find/found reading textbooks an effective way of learning anatomy......	5	4	3	2	1
2. I find/found on-line material an effective way of learning anatomy..........	5	4	3	2	1
3. I find/found material provided by the course an effective way of learning anatomy *(e.g. Handbooks)*...	5	4	3	2	1
4. I find/found using imaging material *(e.g. MRI)* an effective way of learning anatomy	5	4	3	2	1
5. I find/found mock exams an effective way of learning anatomy.............	5	4	3	2	1
6. I find/found Dissecting Room specimens an effective way of learning anatomy	5	4	3	2	1
7. I find/found clinician based teaching an effective way of learning anatomy	5	4	3	2	1
This second cluster asks you about learning on cadavers	Agree	Agree somewhat	Unsure	Disagree somewhat	Disagree
8. The most effective way I learnt anatomy in the Dissecting room is/was to get my hands in and feel for structures....................................	5	4	3	2	1
9. The most effective way I learn/t anatomy in the Dissecting room is/was in groups...	5	4	3	2	1
10. I feel the Dissecting room is a daunting environment to learn in............	5	4	3	2	1
11. I feel that I learned/am learning other things whilst in the Dissecting room *(e.g. natural variation)*...	5	4	3	2	1
12. I feel that working with Cadavers helped me to positively address the issue of death...	5	4	3	2	1
The third cluster of questions asks you about your learning problems	Agree	Agree somewhat	Unsure	Disagree somewhat	Disagree
13. I find/found the amount of anatomy I need/ed to learn daunting.............	5	4	3	2	1
14. I believe that the anatomy resources within the school are limited..........	5	4	3	2	1
15. I have problems learning anatomy because I don't see the point to it.....	5	4	3	2	1
16. I have problems learning anatomy because the teaching styles do not suit me..	5	4	3	2	1
17. I feel course assessments do not reflect the learning that occurs	5	4	3	2	1
18. My main motivation for learning anatomy is to pass exams	5	4	3	2	1
19. I find anatomy learning difficult because it is memorisation based..........	5	4	3	2	1

Part 1. Your experiences of anatomy ...continued					
	Agree	Agree somewhat	Unsure	Disagree somewhat	Disagree
19. I find anatomy learning difficult because it is memorisation based..........	5	4	3	2	1
20. I struggle to build on my anatomy knowledge as I often forget what I learnt last semester/year/s........	5	4	3	2	1
The fourth cluster of questions asks you how you use anatomy at present.	Agree	Agree somewhat	Unsure	Disagree somewhat	Disagree
21. I feel the course allows me to quickly use my anatomy knowledge.........	5	4	3	2	1
22. I have problems using my anatomy knowledge because I am not confident in my knowledge base........	5	4	3	2	1
23. I find that my anatomy learning informs other subject learning................	5	4	3	2	1
24. I find I am using anatomical terms and language at most clinical opportunities	5	4	3	2	1
25. I find I use my anatomy radiology knowledge frequently in clinical situations........	5	4	3	2	1
26. I find I use my surface anatomy knowledge frequently in clinical situations	5	4	3	2	1
This fifth and final cluster of questions asks you about your perceptions of anatomy.	Agree	Agree somewhat	Unsure	Disagree somewhat	Disagree
27. I feel that I will become part of the medical profession once I can fully communicate in medical (anatomical) language........	5	4	3	2	1
28. I feel that understanding anatomy is a very important part of becoming a doctor/dentist/health care professional........	5	4	3	2	1
29. I feel that working with cadaveric material is an important part of becoming a doctor/dentist/health care professional........	5	4	3	2	1
30. My opinions of anatomy's relevance have increased as the course has progressed........	5	4	3	2	1
31. Because of the speciality I am interested in I feel anatomy is not of importance to me	5	4	3	2	1

Appendix D

Student Perceptions of BAHS Survey Instrument:

Survey Monkey (SM) Questions, Question Numbers, and Cross-Referenced Anatomy Learning Experiences (ALE) Question Numbers

ALE	SM	Question
1	10	I found reading textbooks (paper and e-books) an effective way of learning anatomy.
2	11	I found digital material recommended by faculty an effective way of learning anatomy. (e.g., histology, interactive images, items posted to Blackboard)
2	12	I found commercial apps (not faculty recommended/endorsed) (e.g., ADAM, VHP, visible body, nova, bone box)
4	13	I found medical imaging material an effective way of learning anatomy. (e.g. CT, MRI, angiogram, ultrasound)
3	14	I found documents provided by the course an effective way of learning anatomy. (e.g. learning objectives, lab guides)
6	15	I found cadavers and cadaveric specimens an effective way of learning anatomy.
	16	I found animal specimens an effective way of learning anatomy.
2	17	I found virtual cadavers an effective way of learning anatomy (e.g., Cyber-Anatomy Med, 3-D dissection table, Bio-digital human). • Please list the virtual cadaver products you used.
	18	I found living anatomy (using your body or another student's body) an effective way of learning anatomy.
	19	I found plastinated specimens an effective way of learning anatomy (e.g., von Hagens, Bassett).
	20	I found plastic models an effective way of learning anatomy.
	21	I found traditional classroom lectures an effective way of learning anatomy.
2	22	I found watching pre-recorded lectures/PPTs an effective way of learning anatomy. (e.g. flipped classroom)

ALE	SM	Question
7	23	I found clinical concepts taught by clinicians an effective way of learning anatomy.
	24	I found studying in self-chosen small group an effective way of learning anatomy.
	25	I found demonstrating to faculty for a grade an effective way to learn anatomy.
	26	I found working through faculty-led problem based exercises and effective way of learning anatomy.
	27	I found peer teaching when I was the teacher an effective way to learn anatomy.
	28	I found peer teaching when I was the learner an effective way to learn anatomy.
	29	I found preparing a case/topic presentation an effective way of learning anatomy.
	30	I found watching a case/topic presentation an effective way of learning anatomy.
	31	Rank the materials for learning anatomy from most effective (1) to least effective (9). • textbooks and e-textbooks • digital and online material • material provided by the course • medical images (CT, MRI) • cadavers and specimens • animal specimens • virtual cadavers • living anatomy • plastinated specimens • plastic models

ALE	SM	Question
	32	Rank the methods for learning anatomy from most effective (1) to least effective (10). • attending traditional classroom lectures • watching pre-recorded lectures/PPTs • relating clinical concepts presented by clinicians • demonstrating to faculty • working through problem based learning • studying in small groups • being a peer teacher • being a peer learner • preparing a presentation • watching presentations
	33	How did your course utilize cadavers and specimens? • full dissection • prosection with some dissection • prosection • cadaveric specimens • animal specimens (in lieu of cadavers) • the course did not utilize cadavers or cadaveric specimens
8	34	The most effective way I learned was to get my hands in, feel for structures, and manipulate the specimens.
	35	The feel that working with cadavers helped me to develop practitioner-patient interactions.
	36	I feel that working with cadavers is unnecessary.
28	37	I feel that working with cadavers is a vital part of becoming a clinician.
12	38	I feel that working with cadavers helped me to positively address the issue of death.
10	39	I feel that the cadaver laboratory is a daunting environment in which to learn.
	40	I feel more comfortable watching others demonstrate structures on cadavers than touching/dissecting them myself.

ALE	SM	Question
11	41	I feel that I learned other things while in the cadaver laboratory. (e.g. natural variation, communication skills)
9	42	The most effective way I learned in cadaver laboratory was in small groups.
13	43	I found the amount of anatomy material I needed to learn • minimal and unchallenging • appropriate and manageable • daunting and challenging • overwhelming and excessive • Comments
14	44	I found the anatomy resources provided by the school to be limited/insufficient. • Comments
15	45	I have problems learning anatomy because I don't see the point to it.
16	46	I have problems learning anatomy because the teaching styles do not suit me.
17	47	I feel course assessments do not reflect the learning that occurs.
	48	Rank the assessment methods from most effective (1) to least effective (6) representation of your learning. • written examinations • laboratory examinations • demonstration to faculty • case/topic presentation • peer feedback • attendance/participation
	49	Please list additional assessments not mentioned above.
18	50	My main motivation for learning anatomy is to pass exams and pass the course.
19	51	I find learning anatomy difficult because it is memorization based.
	52	I struggle to build on my anatomy knowledge because I find it difficult to remember what I learned during the course.

ALE	SM	Question
21	53	I feel the course allows me to quickly use my anatomy knowledge.
22	54	I have problems using my anatomy knowledge because I am not confident in my knowledge base.
23	55	I find that my anatomy learning serves as a basis other subject learning.
24	56	I find that I am using anatomical terms and language frequently in clinical situations.
25	57	I find that I am using my anatomy medical imaging knowledge frequently in clinical situations.
26	58	I find that I am using my living (surface) anatomy knowledge frequently in clinical situations.
31	59	Because of the specialty I am studying (anesthesiology), I feel anatomy is of low importance to me.
27	60	I feel that I will become part of the medical profession once I can fully communicate in medical (anatomical) language.
28	61	I feel that understanding anatomy is a very important part of becoming an AA.
29	62	I feel that working with cadavers and cadaveric specimens is an important part of becoming an AA.
30	63	My opinion of anatomy's clinical relevance increased as the course progressed.
	64	Please provide any comments or suggestions for this study. • Open-ended response

Appendix E

Participant Informed Consent 2013

Student Perceptions of Anatomy BAHS 500

Statement of Purpose

Title: Investigating anesthesiologist assistant students' perceptions of undergraduate and graduate level human anatomy courses.

Principal Investigator: Sally A. Mitchell, Student, School of Education

Date: March 20, 2014

PURPOSE OF RESEARCH STUDY:
The purpose of this research study is to investigate anesthesiologist assistant (AA) students' perceptions of undergraduate and graduate level human anatomy courses with regard to their (a) approaches to learning and studying, (b) experiences of teaching and learning, and (c) evaluations of teaching and learning materials. The data will provide an overview of current teaching and learning practices utilized in various human anatomy courses. From a pedagogical perspective, the data will inform curricular changes at Emory University Master of Medical Science in Anesthesiology Program.

We anticipate that approximately 40 AA students will participate.

PROCEDURES:
There will be several components for this study:
1. You will be assigned a participant number. All information will be de-identified such that the investigators are blinded.
2. You will be asked to complete a brief survey:
Student Perceptions of Anatomy BAHS 500
3. You may be asked to participate in a brief focus group interview.

Time required: The survey will take 15 minutes. If selected, focus group interviews will take 30 minutes.

RISKS/DISCOMFORTS:
There are no anticipated risks to students.

BENEFITS:
Potential benefits are an increased understanding of how anatomy is taught, what teaching and learning materials are utilized, how students learn anatomy, and students' perceptions of the three aforementioned elements. This study will provide AA programs with comparative quantitative and qualitative data that may be of use in future studies. It is believed that students will better understand their own studying and learning styles through self-reflection.

Student Perceptions of Anatomy BAHS 500

Participant Informed Consent

VOLUNTARY PARTICIPATION AND RIGHT TO WITHDRAW:
Your participation in this study is entirely voluntary. You choose whether you agree to take part in the study. If you decide not to participate, there are no penalties, and you will not lose any benefits to which you would otherwise be entitled.

You can stop participation in the study at any time, without any penalty or loss of benefits. If you want to withdraw from the study, please contact Sally Mitchell via phone or email:
678-358-8138, smitch48@jhu.edu.

CONFIDENTIALITY:
Any study records that identify you will be kept confidential to the extent possible by law. People responsible for making sure that research is done properly, including members of the Johns Hopkins University Homewood Institutional Review Board and officials from government agencies such as the Office for Human Research Protections, may review the records from your participation. (All of these people are required to keep your identity confidential.) Otherwise, records that identify you will be available only to people working on the study, unless you give permission for other people to see the records.

Only the Principal Investigator and research affiliates (including those entities described above) will examine the measures. No identifiable information will be included in any reports of the research published or provided to school administration. A participant number will be assigned to all surveys and focus groups.

Surveys will be collected in an electronic format. Survey data completed electronically will be collected via a password protected Survey Monkey account that belongs to Emory University School of Medicine Master of Medical Science in Anesthesiology Program.

Focus group interview transcripts will de-identified by deleting all names from the transcript and only a participant number or pseudonym will be included on these transcripts.

All research data will be kept in a locked office. Electronic data will be stored on the PI's computer, which is password protected. Any original tapes or electronic files will be erased and paper documents shredded, ten years after collection.

Only group data will be included in publication; no individual data will ever be published.

COMPENSATION:
You will not receive any payment or other compensation for participating in this study.

If you have questions or concerns:
You can ask question about this research study at any time during the study by contacting Sally Mitchell via phone or email: 678-358-8138, smitch48@jhu.edu.

If you have questions about your rights as a research participant or feel that you have not been treated fairly, please call the Homewood Institutional Review Board at Johns Hopkins University at 410-516-6580.

Student Perceptions of Anatomy BAHS 500

*** 1. CONSENT DOCUMENTATION: By completing this survey or questionnaire, you are consenting to be in this research study. Your participation is voluntary and you can stop at any time.**

- ◯ I agree to participate.
- ◯ No thank you. I decline to participate.

Appendix F

Participant Informed Consent 2015

Student Perceptions of Anatomy ANES 525

Statement of Purpose

Title: Investigating anesthesiologist assistant students' perceptions of the human anatomy course ANES 525 Applied Anatomy for Anesthesia Practice.

Principal Investigator: Sally A. Mitchell, Student, School of Education

Date: May 20, 2015

PURPOSE OF RESEARCH STUDY:
The purpose of this research study is to investigate anesthesiologist assistant (AA) students' perceptions of the graduate level human anatomy course ANES 525 Applied Anatomy for Anesthesia Practice with regard to their (a) approaches to learning and studying, (b) experiences of teaching and learning, and (c) evaluations of teaching and learning materials. The data will provide an overview of current teaching and learning practices utilized in ANES 525. From a pedagogical perspective, the data will inform curricular changes at Emory University Master of Medical Science in Anesthesiology Program.

We anticipate that approximately 40 AA students will participate.

PROCEDURES:
There will be several components for this study:
1. You will be assigned a participant number. All information will be de-identified such that the investigators are blinded.
2. You will be asked to complete a brief survey:
Student Perceptions of Anatomy ANES 525
3. You may be asked to participate in a brief focus group interview.

Time required: The survey will take 30 minutes. If selected, focus group interviews will take 30 minutes.

RISKS/DISCOMFORTS:
There are no anticipated risks to students.

BENEFITS:
Potential benefits are an increased understanding of how anatomy is taught, what teaching and learning materials are utilized, how students learn anatomy, and students' perceptions of the three aforementioned elements. This study will provide AA programs with comparative quantitative and qualitative data that may be of use in future studies. It is believed that students will better understand their own studying and learning styles through self-reflection.

Student Perceptions of Anatomy ANES 525

Participant Informed Consent

VOLUNTARY PARTICIPATION AND RIGHT TO WITHDRAW:
Your participation in this study is entirely voluntary. You choose whether you agree to take part in the study. If you decide not to participate, there are no penalties, and you will not lose any benefits to which you would otherwise be entitled.

You can stop participation in the study at any time, without any penalty or loss of benefits. If you want to withdraw from the study, please contact Sally Mitchell via phone or email:
678-358-8138, smitch48@jhu.edu.
If you want to withdraw from the study, and would prefer to have Sally Mitchell blinded to your decision, please contact Dr. Richard Brouillard via phone or email: 404-727-3188, rbrouil@emory.edu.

CONFIDENTIALITY:
Any study records that identify you will be kept confidential to the extent possible by law. People responsible for making sure that research is done properly, including members of the Johns Hopkins University Homewood Institutional Review Board and officials from government agencies such as the Office for Human Research Protections, may review the records from your participation. (All of these people are required to keep your identity confidential.) Otherwise, records that identify you will be available only to people working on the study, unless you give permission for other people to see the records.

Only the Principal Investigator and research affiliates (including those entities described above) will examine the measures. No identifiable information will be included in any reports of the research published or provided to school administration. A participant number will be assigned to all surveys and focus groups.

Surveys will be collected in an electronic format. Survey data completed electronically will be collected via a password protected Survey Monkey account that belongs to Emory University School of Medicine Master of Medical Science in Anesthesiology Program.

Focus group interview transcripts will de-identified by deleting all names from the transcript and only a participant number or pseudonym will be included on these transcripts.

All research data will be kept in a locked office. Electronic data will be stored on the PI's computer, which is password protected. Any original tapes or electronic files will be erased and paper documents shredded, ten years after collection.

Only group data will be included in publication; no individual data will ever be published.

COMPENSATION:
You will not receive any payment or other compensation for participating in this study.

If you have questions or concerns:
You can ask question about this research study at any time during the study by contacting Sally Mitchell via phone or email: 678-358-8138, smitch48@jhu.edu.

If you have questions about your rights as a research participant or feel that you have not been treated fairly, please call the Homewood Institutional Review Board at Johns Hopkins University at 410-516-6580.

Student Perceptions of Anatomy ANES 525

*** 1. CONSENT DOCUMENTATION: By completing this survey or questionnaire, you are consenting to be in this research study. Your participation is voluntary and you can stop at any time.**

- ◯ I agree to participate.
- ◯ No thank you. I decline to participate.

Appendix G

Syllabus ANES 525 Fall 2015

ANES 525 Applied Anatomy for Anesthesia Practice

Fall 2015

Emory University School of Medicine

Master of Medical Science in Anesthesiology Program

Course Director

Sally A. Mitchell, MMSc, CAA

sally.mitchell@emoryhealthcare.org

Course Number ANES 525 Applied Anatomy in Anesthesia Practice
Credit Hours 2
Semester Fall 2015

FACULTY
AA Program Faculty
MD Clinical Faculty
PhD Department of Cell Biology

COURSE DESCRIPTION
This course introduces students to the structure of the human body. Lectures, interactive computer programs, and texts are chosen to assist in active laboratory learning. Students will plan, explore, and present their findings as they pertain to specific course objectives. Through active learning and critical thinking, students will learn a foundation of anatomy, and will learn how to build upon this foundation as their specialized interests continue to develop.

COURSE GOAL
The purpose of this course is to present to the student an account of anatomical facts and concepts needed during one's years of formal study, provide a foundation of anatomical knowledge sufficient to build upon when more detailed knowledge becomes necessary, and to make the study of anatomy more meaningful by emphasizing functional aspects and presenting ways in which anatomical knowledge influences anesthesia and medical practice.

More specifically, the course aims to:
1. Make the student appreciate the importance of anatomy to the practice of anesthesiology.
2. Help the student acquire knowledge and skills (cognitive, psychomotor, affective, and communication) required of an anesthesia provider.
3. Develop the ability of the student to transfer acquired knowledge and skills to subsequent courses and to the clinical environment.
4. Develop schema for lifelong learning.

COURSE OBJECTIVES
After completion of the course, the student should be able to:
1. Describe the structure, function, and relationships of anatomical features of the human body.
2. Demonstrate an anatomical knowledge base for integration with other basic and clinical sciences.
3. Apply anatomical concepts to the practice of medicine, specifically, anesthesiology.
4. Utilize resources to independently advance one's understanding of anatomy, and establish a basis for lifelong learning.

PROFESSIONAL APPEARANCE AND BEHAVIOR

Students are expected to review pages of the SOM Student Policy Manual and AA Program Student Handbook (both available online at emory.edu) regarding Professional Performance Policies. Dress should be of a professional nature, as defined by program policy statements.

Attendance at all class and lab sessions is expected. If there is an unanticipated absence for a session, the course director should be contacted as soon as possible. Timeliness to class is important since it represents consideration for the instructors and your classmates, and it is associated with future employment patterns. A professional warning may be given to students who are late for and/or absent from class without valid reasons, or who fail to notify the course director of an unanticipated absence.

LAB COATS

Each student must have a long, white lab coat for use in the dissecting room. These are available in the bookstore. Each student will be assigned a hook on which to hang the lab coat. The coats will remain in the lab for the duration of the course. This is an OSHA requirement.

DISSECTING INSTRUMENTS & GLOVES

See Blackboard for a list of required instruments and additional details.

REQUIRED TEXTBOOKS

See Blackboard for a list of required textbooks and additional details.

MEANS OF ATTAINING COMPETENCIES

Means include reading, lectures, labs, study, group projects, peer learning, online resource activities, active participation, and self-refection.

LABORATORIES

The most important part of this course is the laboratory. Students will share time at each dissecting table. The lab group assignments are fluid; students will not have dedicated lab groups/partners. Assignments will be made on a daily basis. The laboratory work is subdivided into morning and afternoon sessions. First Year Clinical Rotation Schedule with Sim Labs will serve as the reference. Students assigned to morning anatomy lab sessions are those students that are not otherwise assigned to clinical rotations or simulation lab. Clinical and Sim Lab students will attend afternoon anatomy lab sessions. It is the students' responsibility to notify the course director of any/all scheduling changes.

Based upon the objectives, each group is responsible to dissect and identify structures on cadavers, preserved tissue specimens, bones, plastic models, radiographic images, histology images, osteology (presented in the "Flash lab program" on Blackboard), and living anatomy (i.e., each other).

In addition to gross anatomy and histology lab, students will participate in SCALEs (student-centered active learning exercises). Some SCALEs will be individual assignments, and some will be group projects.

MEANS OF ASSESSING COMPETENCIES

Competency may be assessed using a variety of methods as defined by the course director. Contribution of each component to the final grade is as follows:

Written/CBT Examinations	45%	3 @ 15%
Quizzes (online and in-class)	5%	multiple
Deliverables produced from SCALEs	20%	4 @ 5%
Final Projects	10%	2 @ 5%
Case Reflections	20%	4 @ 5%

GRADING SCALE

A	90.0 % – 100%
B	80.0% – 89.99%
C	70.0% – 79.99%
D	60.0%– 69.99%
F	Below 59.99%

Students who score less than 70% on any examination component will be required to remediate the material.

SCALEs (student-centered applied learning exercises)

1. Correlation/application of anatomy to
    a. Patient's history & physical examination
    b. Surgical diagnoses and procedures
    c. Physiology
    d. Pharmacology
    e. Preanesthetic consultation
    f. Anesthetic case management
2. Clinical skills
3. Problem-based learning group projects
4. Review of a medical journal article
5. Development of an anesthetic care plan
6. Medical simulations

FINAL PROJECT CHOICES

Students significantly increase their intrinsic motivation for learning when they focus on mastery of learning rather than on their performance on tests (Hardiman & Whitman, 2014).

Project choice, self-paced project timeline, interleaving of topics, personal connection to case studies, and allowance for art integration and creativity could be afforded to students through these assessments (E. Gregory et al., 2013; Hardiman & Whitman, 2014; Howland, 2014; L. Rinne et al., 2011).

Students will complete two final projects; choose only one per column.

PPT with voice over	iMovie (video clip)	Physical teaching model
PPT with oral presentation	iBook	Virtual teaching model
Case study critical reflection	Hypertext essay	App
	Review of a journal article	PBL module

ADA STATEMENT

Students who believe that, due to the impact of a disability, they may need academic accommodations in order to meet the requirements of this, or any other class, at Emory University are encouraged to contact the Office of Disabilities Services. Confidentiality will be observed in all inquiries.

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Appendix H

Student Perceptions of ANES 525 Survey Instrument:

Survey Monkey (SM) Questions, Question Numbers, and Cross-Referenced Anatomy Learning Experiences (ALE) Question Numbers

ALE	SM	Question
1	13	I found reading textbooks (paper and e-books) an effective way of learning anatomy.
2	14	I found digital and online material an effective way of learning anatomy. (e.g., interactive images, quizzes, websites, videos, apps)
4	15	I found medical imaging material an effective way of learning anatomy. (e.g. CT, MRI, angiogram, ultrasound)
3	16	I found documents provided by the course an effective way of learning anatomy. (e.g. learning objectives, lab guides)
6	17	I found cadavers and cadaveric specimens an effective way of learning anatomy.
2	18	I found virtual cadavers an effective way of learning anatomy. • Please list the virtual cadaver products you used.
	19	I found living anatomy (using your body or another student's body) an effective way of learning anatomy.
	20	I found plastic models an effective way of learning anatomy.
	21	I found using medical equipment (ultrasound, arterial lines, laryngoscopes) an effective way of learning anatomy.
	22	I found writing case reflections an effective way of learning anatomy.
2	23	I found watching pre-recorded lectures/PPTs/YouTube an effective way of learning anatomy. (e.g. flipped classroom)
7	24	I found clinician based teaching an effective way of learning anatomy.
	25	I found reading clinical journals an effective way of learning anatomy.
	26	I found engaging in discussion boards an effective way of learning anatomy.

ALE	SM	Question
	27	I found studying in small group an effective way of learning anatomy.
	28	I found creating a final project an effective way of learning anatomy.
	29	I found working through problem-based learning exercises an effective way of learning anatomy.
	30	I found preparing a case/topic presentation an effective way of learning anatomy.
	31	I found watching a case/topic presentation an effective way of learning anatomy.
	32	Rank the materials for learning anatomy from most effective (1) to least effective (9). • textbooks and e-textbooks • digital and online material • documents provided by the course • medical images (CT, MRI) • cadavers and specimens • virtual cadavers • living anatomy • plastic models • medical equipment (ultrasound, arterial line, laryngoscope)
	33	Rank the methods for learning anatomy from most effective (1) to least effective (10). • creating a final project • watching pre-recorded lectures/PPTs • reading clinical journals • clinician based teaching • writing case reflections • working through problem based learning • studying in small groups • engaging in discussion boards • preparing a presentation • watching presentations

ALE	SM	Question
8	34	The most effective way I learned was to get my hands in, feel for structures, and manipulate the specimens.
9	35	The most effective way I learned in cadaver laboratory was in small groups.
	36	I feel more comfortable watching others demonstrate structures on cadavers than touching/dissecting them myself.
10	37	I feel that the cadaver laboratory is a daunting environment in which to learn.
11	38	I feel that I learned other things while in the cadaver laboratory. (e.g. natural variation, communication skills)
12	39	I feel that working with cadavers helped me to positively address the issue of death.
	40	I feel that working with cadavers helped me to better relate to patients.
	41	I feel that working with cadavers is unnecessary.
28	42	I feel that working with cadavers is a vital part of becoming a clinician.
13	43	I found the amount of anatomy material I needed to learn • minimal and unchallenging • appropriate and manageable • daunting and challenging • overwhelming and excessive • Comments
14	44	I found the anatomy resources provided by the school to be limited/insufficient. • Comments
15	45	I have problems learning anatomy because I don't see the point to it.
16	46	I have problems learning anatomy because the teaching styles do not suit me.
18	47	My main motivation for learning anatomy is to pass exams and pass the course.
19	48	I find learning anatomy difficult because it is memorization based.
17	49	I feel course assessments do not reflect the learning that occurs.

ALE	SM	Question
	50	Rank the assessment methods from most effective (1) to least effective (6) representation of your learning. • written examinations • case reflections • SCALEs • discussion posts • final projects • attendance/participation
21	51	I feel the course allows me to quickly use my anatomy knowledge.
22	52	I have problems using my anatomy knowledge because I am not confident in my knowledge base.
23	53	I find that my anatomy learning serves as a basis other subject learning.
24	54	I find that I am using anatomical terms and language frequently in clinical situations.
25	55	I find that I am using my anatomy medical imaging knowledge frequently in clinical situations.
26	56	I find that I am using my living (surface) anatomy knowledge frequently in clinical situations.
31	57	Because of the specialty I am studying (anesthesiology), I feel anatomy is of low importance to me.
27	58	I feel that I will become part of the medical profession once I can fully communicate in medical (anatomical) language.
28	59	I feel that understanding anatomy is a very important part of becoming an AA.
29	60	I feel that working with cadavers and cadaveric specimens is an important part of becoming an AA.
30	61	My opinion of anatomy's clinical relevance increased as the course progressed.
	62	Please provide any comments or suggestions for this study. • Open-ended response

Appendix I

Course Schedule ANES 525 Fall 2015

Day Date	Topic	SCALE
T 8/31	Introduction and Orientation to Lab Cells, Tissue - bone cartilage, muscle	
R 9/3	Circulatory – vasculature, blood	Lines – IV, arterial, central
T 9/15	Circulatory – heart, mediastinum PNS – named on list	Lines – IV, arterial, central PNS
R 910	Integument, PNS, Tissue – neuro	Ultrasound for lines
T 9/15	Skeletal – axial – skull, vertebrae	Medical imaging
R 9/17	Lymphatics, Immune System	ACDF, lumbar laminectomy
T 9/22	Skeletal – appendicular, joints	Le Fort, orbital blowout fx
R 9/24	Review	
F 9/25	Exam 1	
T 9/29	Musculature	PNS - muscles, nerves, nerve stimulator placement
R 10/1	Musculature Respiratory – lungs, histology	Bronchospasm, Smoking
T 10/6	Respiratory – pharynx, larynx, lungs	Intubation, Medical imaging
R 10/8	Combined 512 OPE & Adjuncts Lab	
T 10/13	CNS – brain, spinal cord, meninges, CSF Cranial Vasculature	SDH, TIA Spinal, epidural, CSE
R 10/15	ANS & PNS – cranial & spinal nerves	NTs & Rx
F 10/16	Clinical PNS	Ultrasound for PNS
T 10/20	Liver & Portal venous system Abdominal Vasculature	ERCP, lap chole

Day Date	Topic	SCALE
R 10/22	No class – ASA – Endocrine system	
T 10/27	No class – ASA – Digestive system	EGD, PEG, colonoscopy
R 10/29	No class – ASA – Digestive histology	RouxNY, SBO, colostomy
T 11/3	GI, GU, Endocrine (on Exam 3)	Review digestive SCALEs
R 11/5	Renal & Urinary (on Exam 3)	Cysto, TURP, renal transplant
F 11/6	Exam 2	
T 11/10	Reproductive	L&D, ectopic, hysterectomy
R 11/12	Endocrine	Diabetes
T 11/17	Special senses	ENT surgery
R 11/19	Review	
T 11/24	Final Project Workshop	
R 11/26	No class – Thanksgiving	
T 12/1	Final Project Workshop	
R 12/3	Final Project Presentations	
T 12/8	Final Project Presentations	
R 12/10	Final Project Presentations	
T 12/15	Exam 3	

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Curriculum Vitae

Sally Ann Mitchell applied and was accepted to the Johns Hopkins University School of Education Doctor of Education program in 2013. The impetus was the organic development of a specific Problem of Practice within her teaching duties as a graduate level anatomy instructor: She was challenged by the Emory University School of Medicine Master of Medical Science in Anesthesiology program directors to transform a dissection-based basic science course into a technology and clinically based anatomy course for anesthesiologist assistant students. Although she began formally teaching in the didactic program in 2011, her primary professional role remains at Emory University Hospital Midtown as a Certified Anesthesiologist Assistant. As a CAA at a teaching hospital, Sally provides anesthesia care to patients undergoing surgical procedures, and routinely engages in clinical education of anesthesiologist assistant students. She is a Class of 1999 graduate of the Emory AA program.

Prior to attending Emory University, she took graduate courses in medical sciences, participated in teratology research, and worked as a teaching assistant for anatomy and physiology at Indiana University – Bloomington. These experiences provided a substantial scientific knowledge base, introduction to medical education, and opportunity to discover a passion for teaching. Critical thinking and scientific reasoning were honed during her undergraduate years at Hanover College (BA Biology, 1995), a small liberal arts school in southern Indiana.

Sally currently resides in Atlanta with her husband Brad, son Grant, and their extended, blended, modern family. She continues to work and teach at Emory.