Online and Face-to-Face Anatomy Dissection Labs: A Comparison of Levels of Achievement in Learning Outcomes and Perception of Learning and Satisfaction

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Jenna L. Davidson

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We hereby certify that this Dissertation, submitted by your name, conforms to acceptable standards and fully fulfills the Dissertation requirements for the degree of Doctor of Education from College of Saint Mary

Dr. Kristi Preisman, Ph.D.
Chair

Dr. Rita Berthelsen, Ph.D.
Committee member

Dr. Joy Martin, Ph.D.
Committee member

Dedication Page

I dedicate this dissertation to my Dad, my Mom, and my Drew:

I did this for me, I did this for you, and I did this for us. I love you all.

I dedicate this to myself:

She believed she could….so she did.

Acknowledgement Page

Too many people worth mentioning assisted me along the way in this process whether it be reading my work, editing, listening to me, providing insight, and just plain words of encouragement. I'm grateful for support in my life.

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Abstract

This quantitative study examined levels of achievement in learning outcomes when using a face-to-face dissection lab compared to an online dissection lab. Constructivist theory and Understanding by Design learning framework were at the core of this research study design. Data was collected from 24 health science students at a private Midwestern university during an anatomy course. Two assessment tools were utilized to examine the research questions. The first assessment tool was three exams and the second assessment tool was a cross-sectional personal assessment perception of learning and satisfaction survey. Data was collected on learning outcomes of the exams and results of the survey. Data analysis consisted of a one-way ANOVA with a post-hoc tukey on the learning outcomes of the exams and a series of Pearson correlation coefficients were used to analyze results of the personal assessment survey. Results of the three exams revealed there was significant differences between face-to-face learning and online learning, but the results did not favor one learning modality over the other. Instead, the results implied a multi-modal learning style is successful in learning anatomy. The results from the personal assessment survey indicated significant differences in the perception and satisfaction of online learning. However, the results were diverging as they implied there is still a need for face-to-face learning in anatomy, but there is also place for online cadavers in understanding and learning anatomy.

CHAPTER I: INTRODUCTION

This chapter will serve as an overview of the research study and problem. Chapter I will set the intention of the study, background and rationale, establish the problem statement, ascertain research questions, identify limitations and delimitations, determine assumptions, and define terms.

Purpose of the Study

Higher education is facing an unprecedented change revolutionizing the delivery of course content. The traditional method of face-to-face instruction is quickly becoming out paced by the modern modality of online learning (Biasutto, Caussa, & Criado del Rio, 2006; Lao & Gonzales, 2005; Sugand, Abrahams, & Khurana, 2010; Wang, Shannon, & Ross, 2013; Ward, Peters, & Shelley, 2010). In a report by I. E. Allen and Seaman (2016), over 5.8 million students in fall of 2014 were enrolled in at least one online course, which represents 28% of all students in higher education. Online learning is a critical part of strategic growth of higher education institutions (I. E. Allen & Seaman, 2016), and they have evolved to accommodate this incipient development by offering an increasing amount of online classes in order to meet modern student demands. A technology driven culture has induced and amplified the demands of modern higher education students as they want convenience and flexibility thereby causing a surge in demand of learning online (Chou & Liu, 2004; Davis, Bates, Ellis, & Roberts, 2014; S. D. Johnson & Aragon, 2003; Shachar & Neumann, 2010). Studies affirm one of the primary reasons students enroll in online courses is because the choice of when and where to learn can be decided by the student (Hart & Morgan, 2010; Kenny, 2002). Online learning meets these demands by modifying face-to-face courses into a format that requires no presence by the student in a physical classroom, and instead, instruction and learning occur using technology (Rickard, 2010). It appears any collegiate course can be presented in this innovative online format (Wang et al., 2013) which enables higher education institutions to attract students from the world over who have access to the internet and a technology device such as a laptop, tablet, or smartphone. This transforms the act of learning outside of a brick and mortar classroom, which is a dramatic shift from learning in the traditional face-to-face setting that has previously dominated all levels of education.

Online learning is rapidly evolving and expanding in higher education. The main advantage of online learning is that it permits learning to occur at a time and place convenient to the student in an asynchronous learning environment (C. R. Davis et al., 2014; K. K. Davis & Snyder, 2012; Gumport & Chun, 1999; Predavec, 2001; Shachar & Neumann, 2010). As Lao and Gonzales (2005) write, "this entails being able to go to school while meeting the needs of a work and family schedule" (p. 460). Another advantage is online learning is fully accessible no matter where a student is located geographically, and thus, removes learning barriers such as time and location which has previously restricted access to pursuing education. Online learning is rooted in being student-centered (Chou & Liu, 2004; Huang, 2002; Predavec, 2001; Silen, Wirell, Kvist, Nylander, & Smedby, 2008). Therefore, online learning is certainly a propitious option for attaining educational goals when a student is limited by location or life obligations. Consequently, higher education institutions use this geographically unrestricted modality for learning as a means to bolster enrollment (I. E. Allen & Seaman, 2013; I. E. Allen & Seaman, 2016; Smith & Mitry, 2008). Online learning is now an integral part of higher education institutions' strategic growth and future.

It is suggested that all courses in higher education can be presented online (Wang et al., 2013); however, one discipline that is perceived to be difficult to implement into online learning is science (Biasutto et al., 2006; Instructional Technology Council, 2013). This subject area conventionally couples a lecture pertaining to course content with a face-to-face hands-on lab to enhance and support the instructed lecture material. While the lecture is capable of being offered online, transferring activities from a face-to-face lab to an online lab has been challenging for educators (Hughes, 2000; Marszalek & Lockard, 1999; Ma & Nickerson, 2006; Johnson, Charchanti, & Troupis, 2012; Saltarelli, Roseth, & Saltarelli, 2014). When the lab is instructed face-to-face, it often employs the use of models and dissection of an organism to support the learning of anatomy (Codd & Choudhury, 2011; Lombardi, Hicks, Thompson, & Marbach-Ad, 2014; Yammine & Violato, 2015). In order to transfer the lab to online, educators have offered online science labs by utilizing any single or combination of: interactive computer programs, virtual labs, and at-home kits (Anderton, Chiu, & Aulfrey, 2016; Corter et al., 2007; E. O. Johnson et al., 2012; Ma & Nickerson, 2006; Mathiowetz, Yu, & Quake-Rapp, 2016; Rehman, Khan, & Yunus, 2012). Interactive computer programs are designed as an animated science lab taking place on a computer that utilizes graphical lab tools to manipulate the lab (Anderton et al., 2016; Predavec, 2001; Marszalek & Lockard, 1999; Sugand et al., 2010). Virtual labs are a web-accessible mediated reality lab in which an internet-based animated program conducts the mediated experiment (Ma & Nickerson, 2006). At-home kits are a boxed science kit mailed to the students and contain the necessary equipment to complete labs at the student's location of choice (Ma & Nickerson, 2006). Activities that have conventionally occurred in a physical lab can now be accomplished using technology tools afforded by the internet and computer technology. Combining face-to-face labs with online labs technology has created an approach to learning called multi-modal, and this type of learning style has been suggested to be a successful approach to learning anatomy (Biasutto et al., 2005; C. R. Davis et al., 2014; Peat & Taylor, 2004). A multi-modal approach enables the student to have access to a face-to-face lab for kinesthetic learning, and then have access to online lab technology to learn outside the classroom.

The discipline of science encompasses different subject areas including health science. A common course required by a student in health science is human anatomy with an accompanying human anatomy lab. This course pertains to the learning of the structure and identification of parts of the human body (Anderton et al., 2016; C. R. Davis et al., 2014; Mathiowetz et al., 2016; Sugand et al., 2010). In the accompanying human anatomy lab, a common activity to increase depth of knowledge of the human body is dissection of an organism, and in many human anatomy labs, the organism is a deceased human that has willing donate their body to science. Dissection is a unique experience for student learning and is the pinnacle of science labs (Codd & Choudhury, 2011; C. R. Davis et al., 2014; E. O. Johnson et al., 2012). It is widely accepted that human dissection provides 3D views of the internal interrelationships of the human body and provides a kinesthetic and haptic approach to learning the human body (McLachlan, 2004). However, modern technology tools have enabled the development of alternative dissection using the aforementioned alternative lab modalities. It is suggested with recent advances in technology, it is possible to instruct human anatomy without a cadaver (McLachlan, 2004). As purposefully designed as these alternative modalities may be to mimic face-to-face labs, there is concern that the level of achievement in learning outcomes in online learning with these online sciences labs are lacking in comparison to their face-to-face counterparts (Biasutto et al., 2006; Ma & Nickerson, 2006; Mathiowetz et al., 2016; Saltarelli et al., 2014). With fewer resources being dedicated to anatomy education, instructing anatomy needs to continue to be effective, efficient, and evidence-based (C. R. Davis et al., 2014). An area of particular angst pertains to the level of achievement in learning outcomes from dissection of an organism that is performed online. This concern exists because a face-to-face dissection lab presents a deceased organism that students can touch, feel, and manipulate by hand in order to learn. In contrast, an online dissection lab is typically a technology based simulation of an organism comprised of a combination of instructional tools, such as layered prosected images or color coded images that students cannot touch and feel, and manipulation is done with a click of a mouse (Codd & Choudhury, 2011; C. R. Davis et al., 2014; Rehman et al., 2012; Saltarelli et al., 2014). There is concern that the significant differences between these two modalities of learning results in a disparity of levels of achievement in learning outcomes.

In the discipline of science, there exists the population of students who have chosen to pursue health care professions and are known as health science students. These students have chosen careers necessitated in knowing the structure of the human body. Much research on alternative modalities of anatomy dissection have utilized non-science student participants, thereby excluding the health science students whom the learning of anatomy directly affects (Muchovej, 2009; Stuckey-Mitchell & Stuckey-Danner, 2007). What remains to be explored is the levels of achievement in learning outcomes of objectives in online anatomy dissection labs focusing on health science students as there exists a paucity in research addressing this topic (Mathiowetz et al., 2016; Saltarelli et al., 2014; Stuckey-Mitchell & Stuckey-Danner, 2007). Measuring levels of achievement in learning outcomes enables replication of material by continually examining the same phenomenon with different methods (Sussman & Dutter, 2010). In this study, the levels of achievement in learning outcomes will be examined through traditional objective measures in exam score outcomes with using health science students as the population.

While outcome scores have often been used as criterion to measure learning, the scores only reflect a narrow course objective from learning outcomes (J. A. Centra & Gaubatz, 2005). In order to gain a more comprehensive understanding of student learning a personal assessment survey by the student on perception of learning and satisfaction will be employed. The personal assessment survey data gathering tool on perception of learning and satisfaction has been widely used and cited as the measures to evaluate the efficacy of online learning (Eom et al., 2006; M. Graham & Scarborough, 2001). The personal assessment survey provides supplemental information that is valuable in understanding learning online in students.

Although there is research on self-perceived learning online, there is little available research on self-perceived satisfaction in health science students in online learning (J. A. Centra & Gaubatz, 2005; Mathiowetz et al., 2016). Satisfaction is measured by learners' attitudes and beliefs towards online learning (Wu, Tennyson, & Hsia, 2010). Perception of satisfaction by students is beneficial when compared to other data gathering tools in order to evaluate the effectiveness of an educational technique (Allen, Bourhis, Burrell, & Mabry, 2002). In this research, perception learning and satisfaction were examined to deepen the understanding of learning online.

The framework utilized in this study is based on Understanding by Design (UbD) framework which was developed by Grant Wiggins and Jay McTighe. This three-stage "backward planning" process assists instructors in developing curriculum, instructional design, and application of student knowledge through authentic contexts and assessments (Wiggins & McTighe, 2005). The three stages are: Identify Desired Results, Determine Assessment Evidence and Plan Learning Experiences and Instruction. These three stages assist in student understanding and transferring their learning (Wiggins & McTighe, 2005). In this research, the levels of achievement in learning outcomes were established as the desired results, and then the assessment and instruction were based off the learning outcomes. This design assists in effective learning as the focus is on the students' understanding and application using the desired end results (Wiggins & McTighe, 2005). This research study used the framework of UbD to explore the levels of achievement in learning outcomes of health science students and to examine perception of learning and satisfaction.

Background and Rationale

The advent of computer based learning began in the late 1970s and early 1980s as higher education institutions became connected through academic communication networks called BITNET and CSNET (Rickard, 2010). Computer based learning leapt forward in the late 1980s with information networks and communication networks merging to form the Internet. Simultaneously in the 1980s, households increasingly began to have computers that laid the foundation for the rapid and vast expansion of the internet (Lao & Gonzales, 2005; Lahoud & Krichen, 2010). A technology-driven economy emerged, and this, coupled with electronic communication, stimulated the emergence of online learning that stemmed from computer based learning (S. D. Johnson & Aragon, 2003). As internet and technology became more pervasive, the traditional face-to-face higher education classroom began to transform to meet the demands of students. The 1990s saw the development of higher education institutions that were now connected via the internet (Hallyburton & Lunsford, 2013). This encouraged the development of online courses, online programs, and online degrees in which students were no longer required to attend a physical classroom, could work at their own pace, and could do the learning at their convenience (K. K. Davis & Snyder, 2012; Hallyburton & Lunsford, 2013). The internet and technology granted students access to higher education institutions regardless of their proximity to the institution in which they were enrolled.

Leading up to the mid-2000s, online learning's growth was insignificant (Rickard, 2010), and as a result, limited amounts of research focused on it. Adaptation to technology tools in education is often met with resistance and little support, but often the technology tools prevail to generate a wide-spread impact (Gumport & Chun, 1999). Slowly, online learning's popularity began to increase, and it warranted examination in the mid-2000s (Rickard, 2010). A seminal report published in 2007, by a professional organization designed to support the integration of online education into higher education known as the Sloan Consortium (now called the Online Learning Consortium) in collaboration with the Babson Survey Research Group, revealed that nearly 3.5 million students had enrolled in an online course in the fall 2006 term which was close to a 10% increase in enrollment for online courses from the previous academic year (I. E. Allen & Seaman, 2013; Rickard, 2010). This report demonstrated there was a surge in preference for online courses by higher education students, and the popularity of this modality of instruction has continued to grow. From 2006 through 2011, online learning in higher education rose from 20% to over 33% of all students who were enrolled in at least one online class which was over 6.7 million students (I. E. Allen & Seaman, 2013; Docebo, 2014). In a report by I. E. Allen and Seaman (2016), over 5.8 million students in fall of 2014 were enrolled in at least one online course which represents 28% of all students in higher education and is down slightly from previous years. Modern student demands of higher education have changed the options of modalities in which course content is delivered. Students desire accessibility, convenience, and flexibility in their learning (C. R. Davis et al., 2014; Lao & Gonzales, 2005; Wang et al., 2013). These demands have forced academic institutions to offer increased amounts of courses in an online learning format. Online learning enables institutions to serve more students without occupying physical classroom space (Rickard, 2010). Over half of institutions now consider online learning to be an integral part of their continued advancement in higher education (I. E. Allen & Seaman, 2013; I. E. Allen & Seaman, 2016; Ward, Peters, & Shelley, 2010), and more and more academic leaders are valuing online instruction (Docebo, 2014). It is apparent online learning is a prominent modality for learning in higher education, and it does not appear online learning will wane.

Modality of Online Learning

In online learning, the technology utilized changes the approach in which information is transmitted to students, but the content is the same (Gumport & Chun, 1999). The implementation of education to online learning and subsequent employment of technology as the modality in which one learns, more closely resembles the constructivist model (Huang, 2002; Mashaw, 2012). Lecture notes, course content, supplemental material, assessments, and communication occur using internet technology in online learning (Rickard, 2010). Online instruction is rooted in being student centered (Chou & Liu, 2005; Huang, 2002; Predavec, 2001; Rickard, 2010; Silen et al., 2008), and this approach to education is supported by the constructivism learning theory which can be found in Understanding by Design framework.

Constructivist theory is rooted in John Dewey's educational research with influences and contributions from Bruner, Piaget, and Vytogsky. This theory can be applied to traditional face-to-face learning; however, it has been found to be deeply rooted in online learning (Ebert, 2014; Huang, 2002; Li & Liu, 2005). The foundation of constructivist theory is constructed by learners in a process that is impacted by their psychological, physiology, and emotional energy and is heavily influenced by the environment (Mashaw, 2012). Instructors implement courses rooted in constructivism by designing courses in which the learners are in control of their learning experiences through knowledge construction, transferring information and by creating authentic learning tasks that will mimic real-life situations (Loyens, Rikers, & Schmidt, 2009). Students of online learning benefit from having control of their learning experiences and being responsible for their learning performances which are characteristics of constructivism (Loyens et al., 2009). Constructivism can be explained through four facets of the theory. The first is knowledge construction by students. Students use their prior knowledge to construct new knowledge and revise their prior knowledge (Loyens et al., 2009). The second facet is cooperative learning which is fostered by student interaction with instructors and other students (Loyens et al., 2009). This occurs in online classrooms through discussion boards, live webcams, and email with instructors. Metacognition in learning is the third facet. This means students acquire new information from a learning environment in which they can exercise control, known as student centered (Loyens et al., 2009). Online instruction is rooted in being student centered (Chou & Liu, 2005; Huang, 2002; Predavec, 2001; Rickard, 2010; Silen et al., 2008). The fourth facet is instructor designed authentic learning tasks. These tasks are real-life situations that the student may encounter (Loyens et al., 2009). Instructors design online instruction to be active and contain content pertinent to the student's future. Constructivist theory has influence on online instruction.

With online learning, students have the power to be in control of their education experience by deciding when and in what location learning will occur (Rickard, 2010). This enables students to attend a higher education institution without interrupting obligations and responsibilities present in their lives. Research does not identify the attraction of online learning over face-to-face learning to be purely founded in the technology used per se, but instead much of the appeal may be reflective of differences in pedagogy, approaches to instruction, and course design (Iverson, Colky, & Cyboran, 2005; S. D. Johnson & Aragon, 2003; Rickard, 2010). Therefore, online learning is an attractive option to earn a degree in higher education in lieu of a face-to-face option.

Anatomy Education and Online Learning

With the increased access to online learning, many courses are offered in this modality. This evolution of instruction and learning has permitted courses traditionally offered face-to-face to be offered online. One of these courses is human anatomy which is a science discipline course. This course pertains to the learning of the human body and is often a part of future health care professions curriculum. The subject of anatomy is regarded as one of the most important subjects in health sciences and at medical school (C. R. Davis et al., 2014). For health science students, the foundation of their education and careers begins with anatomy of the human body. Typically, instruction over structure and function of the human anatomy is performed during lectures with supportive learning occurring in the accompanying labs, and this supportive learning commonly occurs using a specimen to dissect (Biasutto et al., 2005; C. R. Davis et al., 2014; E. O. Johnson et al., 2012; Sugand, 2010). Dissection enables a student the opportunity to dismember and observe a specimen in-situ which means the specimen is undisturbed in its original state. This dissection enables students to learn and practice on real specimen which can mimic what it will be like to work on a live specimen in a health care career.

The action of dissection occurs during the lab. There are many potential specimens utilized in order to advance learning. For the purposes of this study, the specimen dissected in lab to learn anatomy is a human cadaver or a deceased human being that has donated their body to science. Human cadaver dissection for learning can be traced to European Renaissance era in which dissections of humans were performed in theaters for public observation (Allchin, 2005; Ihde, 2011). With the use of cadavers in dissection, future health profession students have the opportunity to study relationships of structures and become familiar with texture and physical characteristics. Anatomy provides the basis for physical examination, interpreting medical imaging, and performing clinical procedures (C. R. Davis et al., 2014; E. O. Johnson et al., 2012). This is enormously beneficial for students of future health professions to experience, and it provides them with practice with the human body before they achieve health careers (Codd & Choudhury, 2011). The human body is the foundation of their career.

Research continues to support the use of cadaver dissection as a crucial learning experience for students (Anderton et al., 2016; C. R. Davis et al., 2014; E. O. Johnson et al., 2012; Mathiowetz et al., 2016; Sugand et al., 2010). Supporters argue traditional anatomy dissection for health science students promotes haptic, visual, and tactile experience that cannot be mimicked by a computer simulation (Codd & Choudhury, 2011; E. O. Johnson et al., 2012; Mathiowetz et al., 2016; Predavec, 2001; Silen et al., 2008). They argue that it is imperative that future health profession students have this experience before they enter into their career or advanced education. Advocates of cadaver dissection attest it provides a powerful learning experience for the student with a tactile opportunity merging with visual and hands-on sensory (Rehman et al., 2012). The research on anatomy dissection appears to favor a real dissection experience on cadavers.

The most prominent issue in opposition of cadaver dissection labs is the financial cost to maintain (Allchin, 2005; Codd & Choudhury, 2011; Hughes, 2000; Mathiowetz et al., 2016; Mayfield, Ohara, & O’Sullivan, 2013; McLachlan, 2004; Peat & Taylor, 2004; Rehman et al., 2012; Saltarelli et al., 2014). Cadaver labs are expensive to maintain due to the designated space, specific temperature, specialized equipment, and price of cadavers (Mathiowetz et al., 2016; Saltarelli et al., 2014). It is an expense that higher education institutions can replace with a more cost effective alternative of an online lab. Consequently, educators of anatomy have implemented a large variety of alternative methods to instructing cadaver dissection such as computer-program instruction, web-based learning, 3D simulation, and prosected images (E. O. Johnson et al., 2012; Mathiowetz et al., 2016; Mayfield et al., 2013; Sugand et al., 2010). Proponents of cadaver online dissection argue that modern technology and simulation capabilities can be utilized in lieu of cadaver face-to-face dissection. With the latest technology in touch screen tablet and smartphones, students are no longer tethered to a learning device that is location bound such as a cadaver, but instead the technology is portable and has to the ability to be instinctively manipulated to examine structures (Mayfield et al., 2013). For technology savvy students, virtual cadaver online dissection labs that are computer based are easy to manipulate and appeal to the visual and auditory modalities while still forcing the student to be actively involved (C. R. Davis et al., 2014; Stuckey-Mitchell & Stuckey-Danner, 2007; Silen et al., 2008). Virtual cadaver online dissection labs permit the combination of physical and virtual sensations, have a high degree of interactivity with active participation, and allows students to see all the structures while working at their own pace (Corter et al., 2007; C. R. Davis et al., 2014; E. O. Johnson et al., 2012; Predavec, 2001; Rehman et al., 2012). Based on research, it seems cadaver online dissection labs have valuable strengths for instructing and learning.

An emerging method to learning anatomy is a multi-modal approach which combines both a face-to-face lab with an online lab. Students utilize a cadaver to study while attending the designated lab times at the physical face-to-face lab. This appeals to the kinesthetic learner and provides the opportunity to examine the interrelationships of the human body. While away from campus without access to the face-to-face lab, students utilize an online lab. The online lab removes the barrier of having to be physically present to study as well as appeals to the tech savvy modern learner. It meets the demands of convenience and flexibility. The multi-modal approach combines face-to-face learning and online learning which increases the potential for successful outcomes in students with multiple and different learning styles.

There is limited research on cadaver online dissection labs, however, there is research on dissection labs in general. Some studies reveal traditional face-to-face dissection learning outcomes are significantly better than any alternative format of dissection (Cross & Cross, 2004; Mathiowetz et al., 2016; Saltarelli et al., 2014). While other research shows students of online dissection outperformed those of face-to-face dissection (Codd & Choudhury, 2011; Predavec, 2001; Yammine & Violato, 2015;). Some researchers found students valued online dissection at the same level as face-to-face (Codd & Choudhury, 2011). However, critics argue online dissections labs are not real as opposed to face-to-face dissections being real (Corter et al., 2007). With this information, it appears the research in the levels of achievement in learning outcomes is varied, and there exists a need for research on learning outcomes of cadaver online dissection.

Learning Outcomes in Online Learning

There is a prevailing concern pertaining to the levels of achievement in learning outcomes that occur in courses delivered and instructed online. Learning outcomes are commonly used in education classrooms to assist in the design and delivery of the course content and to assess the learning that is occurring by the students (Sussman & Dutter, 2010). The framework utilized in this study is Understanding by Design which is a three-stage backward planning process which establishes learning outcomes in courses as the first stage. This guides the assessments, instruction, and learning of the content (Wiggins & McTighe, 2005).

Many institutions use common learning outcomes to align the course offerings and increase the transferability. Therefore, learning outcomes are designed to be equivalent regardless of the modality in which it is being delivered and instructed. Nevertheless, there is concern if levels of achievement in learning outcomes of online learning are equivalent to the levels of achievement in face-to-face learning outcomes.

This concern about the levels of achievement in learning outcomes of online learning has existed since the advent of computer based instruction (Rickard, 2010). Some proponents claim the efficiency, access, and quality of the advances in technology will revolutionize higher education instruction and learning practices, while some skeptics contest technology has undermined higher education quality instruction and diluted student learning (Gumport & Chun, 1999). Research on levels of achievement in learning outcomes reveals mixed results. In 2009, the United States Department of Education's Office of Planning, Evaluation, and Policy Development published a landmark report regarding efficacy of online learning. Their report revealed students of online instruction performed better on average than students of face-to-face instruction (Rickard, 2010). Additional studies corroborate as research results indicate online learning results are higher than face-to-face (Koutsabasis, Stavrakis, Spyrou, & Darzentas, 2011; Means, Toyama, Murphy, Bakia, & Jones, 2009; Mottarella, Fritzsche, & Parrish, 2004; Neuhauser, 2002; Shachar & Neumann, 2010). Some studies found there is no significant differences in learning outcomes when comparing online and face-to-face learning outcomes (Ma & Nickerson, 2006; Olson & Wisher, 2002; Russell, 2001; Sussman & Dutter, 2010). Moreover, some research found students of face-to-face learning outperformed students of online learning (Emerson & MacKay, 2011; Garman, 2012; Hughes, 2000). This conflicting data further confounds the issue of levels of achievement in learning outcomes of online learning.

Perception of Learning and Satisfaction

In addition to the learning outcomes, a vital component for a deeper understanding of student learning is a personal assessment of perception of learning and satisfaction. This personal assessment survey data gathering tool has been used to measure the effectiveness of online learning (Eom et al., 2006). It is important to gain students' perspective on their learning as it reflects a different perspective than objective measures (J. Herrington & Parker, 2013; Huang, 2002). Student satisfaction is one type of evaluation for instructional effectiveness in online learning and should be considered with other evaluation tools (M. Allen et al., 2002). Students may have the presumption that online courses are easier, but the reality is learning online requires more self-discipline, time-management skills, and self-accountability (Rickard, 2010). These data gathering tools provide an alternative, but valuable, perspective on learning in which the individuals most affected will be able to provide personal assessment of their learning.

Although there is research on self-perceived learning and satisfaction, little has been performed on health science students. The limited research on health science students is mixed on perception of learning and satisfaction in learning online. Some studies showed positive student perception of learning online with students learning more or just the same in learning online (Chen & Chuang, 2012; Iverson et al., 2005; Kelly, Lyng, McGrath, & Cannon, 2009; Leners, Wilson, & Sitzman, 2007; Mathiowetz et al., 2016). While other studies reveal more negative perceptions of learning online with students learning less than face-to-face (Haigh, 2007; Palmer & Holt, 2009; Shin & Chan, 2004). It is apparent there are varied perceptions on learning online.

Problem Statement

With the expansion of online education, emerging trends in anatomy education have evolved to less hands-on dissection and more use of interactive computer-based or web-based learning with prosected or plastinated specimens (Codd & Choudhury, 2011; Fancovicova & Prokop, 2014; Ma, & Nickerson, 2006; Mathiowetz et al., 2016; Neuhauser, 2002; Saltarelli et al., 2014; Schoon, 2014; Stuckey-Mitchell & Stuckey-Danner, 2007; Yammine & Violato, 2015). A thorough and in-depth understanding of the human body is integral to future health professionals. The traditional method of face-to-face delivery of anatomy dissection is quickly getting out paced by the modality of online dissection which is lacking haptic and kinesthetic learning, but increases active learning (Palmer & Holt, 2009; Shachar & Neumann, 2010). Anatomy dissection benefits health science students in their future health profession clinical practice, and offering online dissection has created concern as to whether or not the levels of achievement in learning outcomes are the same as face-to-face dissection. According to I. E. Allen and Seaman (2013), over 6.7 million students are enrolled in at least one online course. With this number expected to increase and with the lack of research regarding this trend, it is critical to the advancement higher education in the health sciences to research online anatomy dissection.

The focus of this study was to investigate if levels of achievement in learning outcomes of online anatomy dissection are equivalent to levels of achievement in learning outcomes of face-to-face anatomy dissection in a population of health science students. Further exploration examined perception of learning and satisfaction in health science students. A research study of online anatomy dissection was warranted for several reasons. First, due to the cost of operating a cadaver lab, many institutions are forgoing this learning experience, and instead are utilizing a different modality. This research can assist in revealing effects of alternative modalities on learning outcomes. Second, with the rise in online courses, health science courses such as anatomy with an accompanying lab will increasingly be offered in this modality. Therefore, this research study may be beneficial for increasing the understanding of online anatomy dissection and assist faculty in facilitating online anatomy dissection. Lastly, this research explored the aspects of technology, content, and pedagogy pertaining to online anatomy dissection which is an area that lacks depth of research.

Purpose

The purpose of this experimental study was to compare the levels of achievement in learning outcomes of face-to-face anatomy dissection instruction to online anatomy dissection instruction in a population of health science students. It also examined perception of learning and satisfaction of online anatomy dissection lab students at a private Midwestern university. The independent variable was the modality in which the instruction is occurring which was face-to-face or online. The dependent variables were the levels of achievement in learning outcomes from an instructor written examination and students' self-perceived learning and satisfaction based off a personal assessment survey.

Research Questions

This study addressed two research questions to examine face-to-face and online learning in anatomy dissection labs. The questions are rooted in constructivist theory and UbD framework. The levels of achievement in learning outcomes are based upon UbD step one of desired results. The learning outcomes as well as perceptions of learning and satisfaction are rooted in the constructivist theory of student-centered learning.

1. Do levels of achievement in learning outcomes differ on examinations for undergraduate health science students when using a face-to-face dissection lab compared to an online dissection lab at a private Midwestern university?
2. What are undergraduate health science students' rated perceptions of learning and satisfaction of online anatomy dissection labs at a private Midwestern university?

Significance of Study

Science courses commonly come with an accompanying lab portion that may include dissection. Many institutions are using some alternative form of a dissection lab for online learning and forgoing a face-to-face dissection lab due to the expense of operating a dissection lab. For example, replacing a cadaver dissection lab with a virtual cadaver dissection lab is an example of this alternative form and is less expensive for a higher education institution. It is necessary to research if the levels of achievement in learning outcomes of online anatomy dissection are equivalent to face-to-face anatomy dissection. Equivalent levels of achievement in learning outcomes in online and face-to-face higher education instruction are important for course consistency and transferability in higher education. There is concern the levels of achievement in learning outcomes of the online learning counterpart are not equivalent. At present, there are few studies that specifically address online anatomy dissection labs compared to face-to-face anatomy dissection labs with measuring learning outcomes (Mathiowetz et al., 2016; Saltarelli et al., 2014). In addition, there is a paucity in using health science students as the population (Ma & Nickerson, 2006). This research serves to fill these gaps.

This study explored if the levels of achievement in learning outcomes are the same in online anatomy dissection and face-to-face anatomy dissection. If the levels of achievement are not equivalent, then more research needs to look into the delivery of online anatomy dissection, examine techniques utilized, and review the modality used as the levels of achievement in learning outcomes are to be the same regardless of the modality used. Learning outcomes assist in guiding course content and establishing levels of achievements for students. The levels of achievement in learning outcomes are significant as they demonstrate if equivalent learning is occurring in online anatomy dissection labs when compared to face-to-face anatomy dissection labs. Gaining information from learning outcomes is significant for deepening the understanding of online anatomy dissection labs and assisting faculty in facilitating online anatomy dissection more effectively in future offerings. In addition, this information is beneficial for institutions to consider when making a decision about the expense to maintain a cadaver lab versus the less expensive option of an online cadaver lab.

Examining self-perceived learning and satisfaction through a survey is significant as it is reflective of students' perceptions of their learning with online and face-to-face modalities. These perceptions are important to consider when designing modalities and tools for instructing dissection online. Therefore, the outcomes of the survey will inform the literature on offerings of online anatomy dissection.

This research study is beneficial for course designers and instructors of science related courses. The learning outcomes results examined in this research could contribute to the method of instruction and learning of anatomy in higher education. This could transfer into other areas of science and influence course offerings. This research study is also significant for higher education leadership as the results could contribute to decisions on the approach to instruction of anatomy when considering supporting a face-to-face cadaver lab or an online cadaver lab. There is limited research on comparing these two modalities of anatomy cadaver labs, therefore, this research study is contributing to the limited research.

Limitations and Delimitations

The participants in this study were health science students from a private Midwestern university, and therefore, the results obtained may not apply to all levels and all disciplines of education. There were four major areas of limitations: modalities studied, course subject, sample parameters, and assessments.

Modalities Studied

Online and face-to-face learning were the modalities researched. The online learning studied in this research was focused on asynchronous learning, and the face-to-face learning was focused on synchronous learning.

Course Subject

The research focused on one course subject in a specific discipline. Therefore, it may not be a representation of other courses and other disciplines. In addition, the research focused on one instructional tool of science labs, dissection, as well as one organism that was dissected. Therefore, it may not represent other instructional tools employed in science labs or other organisms dissected.

Sample Parameters

The sample selected for this study was specifically students who were pursuing a health profession career, and as a result, are identified as health science students. The results obtained in this study may be applicable to students outside of this designation. In addition, the sample utilized is from a private Midwestern university. Thus, results may be applicable to other institutions. The researcher did not collect demographics of the sample.

Assessments

Examinations developed by the researcher who also acted as the instructor were utilized to measure learning outcomes. The perception of learning and satisfaction survey was adapted from similar tool reported in the literature.

Assumptions of This Research Study

The focus of this study was on levels of achievement in learning outcomes and self-perceived learning and satisfaction. It is assumed that if all sections of a course are using the same learning outcomes, then assessments based on these established learning outcomes can be compared no matter the format of course delivery. The learning outcomes were created by faculty of the institution in which the researcher was a member. The assessments were designed by the researcher who acted as one of the instructors and were based upon the learning outcomes. The examination questions utilized in this research were validated based upon prior use and selected by the faculty of the institution as they assessed the learning outcomes. The survey was adapted by the researcher from a similar tool in the literature.

It is assumed the participants in the research study were motivated to learn and fulfilled all components of the research to best of their ability. Therefore, the answers on the examination and survey were completed with honesty and integrity by the participants.

Definition of Terms

Asynchronous. Asynchronous describes learning that does not happen in real-time as the learning is done at the discretion and convenience of the individual (Vonderwell, Liang & Alderman, 2007).

Online learning. Online learning is an asynchronous learning experience that is dependent upon computer technologies for most or all the delivery of the content by utilizing the internet and other communication technologies (I. E. Allen & Seaman, 2016).

Constructivism. Constructivism is a theory of learning based in interaction occurring between the learner and his or her environment with knowledge being constructed and enhanced through real experiences (Huang, 2002).

Health Science students. Health science is a designation students seeking pre-healthcare professions and are students of a private Midwestern health science university (Mathiowetz et al., 2016).

Face-to-face. Face-to-face is course content that is delivered through an organized in person meeting with scheduled in physical classroom activities (Ke & Hoadley, 2009).

Virtual Lab. Virtual lab is any remote web-accessible lab in which a student does not have be physically present in the lab and utilizes the internet or computer program to conduct the experiment (Corter et al., 2007).

Private Midwestern University. A private coeducational institution accredited by the Higher Learning Commission with over 700 students.

Synchronous. Synchronous describes learning that happens in real-time as the learning is at the same time and is externally controlled outside of the learner (Vonderwell et al., 2007).

Dissection. Dissection is method utilized in a science lab to prosect 3D organisms in order to fully understand anatomy structures and their function (Yammine & Violato, 2015).

Lab. Lab is distinguished by students being physically present in a designated lab and the equipment utilized to perform the lab is set up in the physical room (Ma & Nickerson, 2006).

Satisfaction. Satisfaction is the perception of success in the learning experience (Sweeney & Ingram, 2001).

Learning Outcomes. Learning outcomes are stated objectives that guide course content and assessment and establish what a student should be able to accomplish (Eom et al., 2006)

Self-perceived learning. Self-perceived learning is a personal assessment examining the level to which one obtained knowledge (Eom et al., 2006).

Summary

There is an increase in online learning courses offered by higher education institutions as this meets the demands of modern students need for convenience and flexibility. Due to this demand, higher education institutions are offering online labs to accompanying science lecture courses. There is concern pertaining to the levels of achievement in learning outcomes of online labs particularly in online anatomy dissection labs. The study focused on levels of achievement in learning outcomes from online anatomy dissection in comparison to face-to-face anatomy dissection as well as examined perception of learning and satisfaction through a survey. The assessment and survey will assist in deepening the understanding of online anatomy dissection labs. The results may provide valuable information used to inform instruction in future offerings of online anatomy dissection labs.

The chapters in this research include a review of literature in chapter two on virtual labs, dissection in labs, the framework that supports the research, and the perception of learning and satisfaction. This chapter is followed by the methods and procedures in chapter three which provides the details of the research design and data gathering tools. Chapter four will discuss data results and summarize significant findings. The final chapter will conclude the research with suggestions for future research.

CHAPTER II: LITERATURE REVIEW

This chapter includes the relevant literature supporting and establishing the context of online anatomy dissection with supportive theoretical evidence. The overview will focus on the following topics: 1) virtual labs; 2) dissection in labs; 3) learning outcomes; 4) assessments; 5) student learning; and 6) perception of learning and satisfaction.

There are many terms utilized to describe online learning. Examples of some terms that are utilized include, but are not limited to: distance learning, distance education, e-learning, and asynchronous learning. Online learning also encompasses different modalities for learning that are termed web-based classes, hybrid classes, blended classes, e-learning, and geographic limited learning. For the purpose of this research, online learning will be the term employed that meets the definition from the Online Learning Consortium (OLC). The criterion from the OLC constitutes online learning is a course which is accessed online with all course content and activity completed employing internet and communicative technology, and there are no requirements for on-campus activity or face-to-face sessions (Hallyburton & Lunsford, 2013; Mayadas & Miller, 2012). Consequently, *online learning* will be the term used.

The focus of the study will be online learning in online anatomy dissection labs, but face-to-face learning warrants a definition to establish clarity. There are many terms that describe face-to-face learning such as traditional learning, synchronous learning, F2F, and brick and mortar learning. For the purposes of the research, the definition for face-to-face is course content that is delivered through an organized face-to-face class meeting with scheduled face-to-face class activities (Ke & Hoadley, 2009; Mayadas & Miller, 2012). Therefore, the term *face-to-face* will be employed as it meets the criterion established by the OLC.

When describing virtual labs, terms such as remote labs, simulated labs, web labs, online labs, and distributed learning labs are all employed to describe labs occurring virtually which accompany science courses. When science courses meet face-to-face, the labs are described as hands-on labs. Hands-on labs are distinguished by students being physically present in a lab and the equipment utilized to perform the lab is set up in the physical room (Ma & Nickerson, 2006). Due to the focus of the research being on online science labs, the term *virtual labs* will be used to encompass any remote web-accessible lab in which a student does not have be physically present in the lab and utilizes the internet or computer program to conduct the experiment (Corter et al., 2007; Koretsky, Kelly, & Gummer, 2011). This clarification will ensure there will no confusion with terminology.

The focus of this research is online dissection science labs in higher education, and therefore, the review of literature is reflective of this focus. The focus in this study will be on science dissection labs offered through accredited universities; it does not include MOOCs, blended courses, or hybrid courses. The concentration of the term *science* used in this research means the science stems from the following subject disciplines: biology, chemistry, physics, and ecology.

Virtual Labs

In many traditional face-to-face science courses, there is a lecture class with an accompanying lab session. The lecture is where the delivery of the content occurs while the lab is where the content is applied. The lab session is considered to be “wet” which means this is where scientific experiments will be conducted (Hughes, 2000). In lab, students apply the skills they have acquired in order to identify the science phenomenon, to learn about it, and to apply the inquiry skills to comprehend the phenomenon (Zion et al., 2004). When offering online science courses, one of the challenges institutions must grapple with is how to instruct virtual labs that accompany the online science courses. Science lab procedures require specialized and expensive equipment as well as chemicals and organisms in order to conduct labs (Corter et al., 2007; Peat & Taylor, 2004). Online learning students are not physically present in the lab, and therefore, the virtual lab must contain the same equipment, chemicals, and organisms that are found in a face-to-face lab (Ma & Nickerson, 2006). Online science courses have an accompanying virtual lab that is a replication of hands-on lab, but utilizing a different modality and technology to accomplish the lab.

Context of Virtual Labs

Virtual labs are replications of face-to-face science labs, as they include a medium to interact, no limitations by time or physical restrictions, easy-to-use tools for lab manipulation, and step by step instructions for conducting experiments (Nedic, Machotka, & Nafalski, 2003). Students have the opportunity to still perform experiments using "real" virtual equipment in a virtual lab (Nedic et al., 2003). The advantages of virtual labs are students can complete the learning from anywhere they choose (Peat & Taylor, 2004; Predavec, 2001), and students can repeat the experiments in the virtual labs over and over again (Predavec, 2001). Virtual lab experience combines visual and auditory modalities of learning (Stuckey-Mitchell, & Stuckey-Danner, 2007). The literature on virtual labs in this study is reflective of virtual lab experience, effectiveness, and concerns.

Virtual Labs Experience

Virtual labs provide "cognitive realism" as opposed to authentic and real experiences gained from face-to-face labs (J. Herrington, 2006). In some aspects, the technology employed in virtual labs is more effective than the authentic experience because it provides limitless access to information and manipulation of lab technology without the constraints of place and time (Gumport & Chun, 1999; Sauter, Uttal, Rapp, Downing, & Jona, 2013). At its most basic level, the technology of online learning in virtual labs has affected the nature of knowledge and the delivery of knowledge (Gumport & Chun, 1999). Technology molds knowledge, shapes how it is produced, influences people involved in the production of knowledge, and affects those gaining the knowledge (Gumport & Chun, 1999). The technology employed in online learning of virtual labs is extremely malleable, arguably still in its infancy, and limitless in its number of applications (Gumport & Chun, 1999; Haluck & Krummel, 2000). With online learning, the computer's world is the user's world, and therefore, the experiences of the user occur in that world with ever-changing situations which responds to the user's actions (Witmer & Singer, 1998). The application of virtual labs may transition learning from passive to active (Gumport & Chun, 1999). Technology of virtual labs will continue to evolve and change which will influence learning outcomes, students, and instructors of online learning courses (Milam, Voorhees, & Bedard-Voorhees, 2004). There is support for virtual lab technology which has enabled virtual labs to be used in online learning.

Nedic et al. (2003) found well-designed virtual labs are more adept in explaining challenging concepts and provide the opportunity for safe experimentation and manipulation with dangerous equipment. Virtual labs provide students with the data that can be analyzed which encourages student interpreting, communication, and report writing skills (Hughes, 2000) and permits students to be more efficient with their learning (Mayfield et al., 2013). Students in research performed by Hughes (2000) found virtual science labs to be preferred because the face-to-face labs resulted in acquisition of inconsistent data, errors in manipulation, and errors in results. In further support, Sauter et al.'s (2013) research on over 120 participants noted students perceived their virtual labs to be more like a face-to-face lab. Evidence indicates virtual labs can create an experience similar to face-to-face labs.

Virtual Labs Effectiveness

Research indicates students perceived virtual labs to be just as effective and slightly more effective than face-to-face labs. In research done by Stuckey-Mitchell and Stuckey-Danner (2007), researchers found 60% of students perceived virtual labs to increase their understanding of course content, however, 87% of students found face-to-face labs increased their understanding as well. Corter, Nickerson, Esche, and Chassapis's (2004) research on 29 student participants revealed more than 90% of the student sample rated the effectiveness and impact of virtual labs to be more effective than or just as effective as face-to-face labs. The highest rated aspect of virtual labs in this research was their convenience and flexibility for students while the lowest rated aspect was lack of feeling immersed (Corter et al., 2004). In research performed later, Corter et al. (2007) compared remote, hands-on, and simulated labs in 306 student participants. Their research revealed knowledge scores were the highest with virtual labs followed by simulated labs then hands-on labs. However, students rated hands-on labs as more effective in education than virtual or simulated labs. These students rated effectiveness of virtual labs as the same as hands-on at 49.3%, while 39.4% rated hands-on labs as less effective, and the remaining 11.3% rated virtual labs as more effective (Corter et al., 2007). Virtual labs are supported with evidence for being as effective as face-to-face labs.

A quantitative study performed by Koretsky et al. (2011) focused on students' evaluations of virtual labs in comparison to physical labs. The researchers utilized a survey administered to 45 students. The researchers determined virtual labs to be effective for increased learning, increased critical thinking, and increased understanding of experimental design

(Koretsky et al., 2011). Physical labs demonstrated high lab protocol understanding which indicated a weakness in virtual labs. The researchers found that the difference in evaluation of the virtual labs in comparison to face-to-face labs was not related to the modality of the laboratory, but the difference is related to the instructional design of the face-to-face and virtual labs (Koretsky et al., 2011). This presents a compelling point that the instruction is the difference in effectiveness and not the modality of learning.

Virtual Labs Concerns

It is currently believed by faculty that students pursuing a deep academic study in sciences should be a student of hands-on labs so the student will know how to operate lab equipment and run experiments (Corter et al., 2007; Stuckey-Mitchell & Stuckey-Danner, 2007). One of the fears of virtual labs is science students will enroll in virtual labs and will not acquire the hands-on experience or the know-how of science experiments (Corter et al., 2007; Silen et al., 2008). Moreover, there is concern about the future of healthcare workers and virtual labs.

Questions arise about the realism, efficacy, and safety of students in virtual labs who desire to be an employee of the healthcare field (Silen et al., 2008). Virtual labs result in missing the physicality and kinesthetic experience with laboratory equipment and experiments. Virtual labs do not feel the same as face-to-face labs (Scanlon, Colwell, Cooper, & Di Paolo, 2004), and online labs create a feeling of disconnectedness from the real laboratory equipment and tools (Corter et al., 2007). Hands-on experiences in science courses and science labs are extremely beneficial for student learning (Hughes, 2000; Stohr-Hunt, 1996). Future occupations need students to be exposed to manipulation of lab equipment and lab research in order to prepare and virtual labs cannot suffice this exposure (Corter et al., 2007; Kelly et al., 2009). Students are enticed to work on problems that are authentic to the experience of the future working environment (Wright, 1996), and therefore, students may see virtual labs not as authentic to real lab experience. Without the real hands-on manipulation of real equipment, virtual labs were not considered to be as real as hands-on learning in science labs in research on 38 students (Stuckey-Mitchell & Stuckey-Danner, 2007). A meta-analysis study by Ma and Nickerson (2006) suggested most virtual labs addressed conceptual understanding and professional skills, but lacked design skills and social skills. However, the process of implementing virtual labs requires changes to the learning and teaching objectives which may prevent adequate comparison of face-to-face labs to virtual labs (Scanlon et al., 2004). There is evidence of concerns related to virtual labs.

Virtual labs accompany online science courses and literature indicates virtual labs can mimic face-to-face lab experience and effectiveness. However, concerns over the efficacy of virtual labs and science students gaining the necessary lab skills as well as exposure to scientific processes demonstrates the need for further examination. While there is literature support for virtual labs being successful and effective for learning, there is sufficient concern about the shortcomings of virtual labs. Therefore, the purpose of this research is pertinent and warranted to further examine virtual labs.

Dissection in Labs

The epitome of most science labs is dissections of organisms as it provides the student with a kinesthetic experience of learning the internal structure of an organism. Dissection of specimens is an integral facet of science courses (Mayfield et al., 2013). Dissection is a powerful learning tool as the students utilize all their senses, and it incorporates all the different modalities for learning (Mayfield et al., 2013). Higher education institutions and science professionals value the exposure to the real specimen, albeit deceased, in order to foster deep learning about form and function of the organism (Codd & Choudhury, 2011; Yammine & Violato, 2015). The experience of dissection in science labs allows the individual to gain a rare internal view of the specimen while learning about the interrelations to structures internally and the form of the structures. With online science courses and accompanying virtual labs, dissections that normally occur in a physical classroom now must be completed in an alternative method for online learning.

Dissection

Physical dissection occurs at a specific date and time in a physical classroom while virtual dissection is completed at the discretion of the student and uses an alternative to a real specimen. Alternatives to physical dissection include computer simulations, 3D models, and videos (Allchin, 2005; Peat & Taylor, 2004). Anatomical virtual labs allow students to manipulate the imagery of the body by using a computer mouse to change views of the body (Silen et al., 2008). The expectations of learning from dissections need to be mirrored from physical dissection to virtual dissection. Virtual dissection removes smells and liquids from dissection which can be an optimal option for students, and therefore, virtual dissection can be a positive alternative in lieu of real dissection.

Support for physical dissection. Silen et al. (2008) researched over 50 medical students' perceptions of physical dissection compared to virtual dissection. They claimed students preferred the virtual dissection as it permitted them to learn about the size and shape of internal organs and structures, however, they did not want to lose the experience of physical dissection because the feel and orientation of the dissection is cannot be achieved by virtual dissection. Ihde (2011) found virtual dissection is a poor imitation of a physical dissection. The dissector makes "cuts" with a mouse click, and it is somewhat a form of entertainment with colored imagery and music (Ihde, 2011). In further support, Peat and Taylor's (2004) research reported physical dissection increased understanding interrelationships and structure whereas virtual dissection was more useful for function. Students reported there is still a need for authentic physical lab activities over virtual lab activities (Peat and Taylor, 2004). It is evident students still value the experience of dissection on physical specimens.

There is support that physical dissection results in higher learning outcomes for students. Fancovicova and Prokop (2014) revealed exam scores were higher for 59 participants in which anatomy was instructed by an instructor as opposed to independent learning on dissections or 3D plastic models. When comparing an interactive tutorial, computer simulation, and physical dissection Marszalek and Lockard (1999) noted physical dissection resulted in higher retention with an immediate posttest and delayed posttest scores in 280 middle school participants. In further support, Cross and Cross (2004) noted students who completed the laboratory practical after dissecting a physical specimen outperformed students who dissected a virtual specimen. A study by Mathiowetz et al. (2016), utilized a posttest only research of higher education students to assess the comparison in learning outcomes between students who had enrolled in an online virtual anatomy dissection and students enrolled in cadaver anatomy dissection. Results indicated students enrolled in cadaver anatomy dissection performed significantly higher in when examining course grades than students in virtual anatomy dissection, and these students spent an increased time utilizing the specimen for learning than students in the virtual dissection (Mathiowetz et al., 2016). This is further supported by Saltarelli et al.'s (2014) comparison of an anatomy dissection multimedia software to cadaver based dissection. Results indicated there was a significant difference in learning outcomes of cadaver based dissection over virtual dissection with cadaver based dissection showing an increase in learning outcomes. The utilization of physical specimens in science labs can result in higher learning outcomes than the use of virtual specimens.

Support for virtual dissection. In contrast to success with physical specimens, Hughes (2000) found students in virtual dissection performed higher than the physical dissection. Lalley, Piotrowksi, Battaglia, Brophy, and Chugh (2010) compared the application of a virtual dissection program to physical dissection in learning outcomes in over 100 high school students. They found students who completed the virtual dissections had higher posttest scores than those who had completed physical dissections. Researchers found interactive virtual dissection was as effective as the physical dissection in promoting learning about the specimen and dissection procedures in research by Kinzie, Strauss, and Foss (1993). Codd and Choudhury (2011) utilized a virtual 3D cadaver to instruct anatomy to higher education students. Results indicated knowledge tests of the 3D virtual dissection students were significantly higher than students of physical dissection. However, students still preferred the physical dissection over the 3D virtual dissection (Codd & Choudhury, 2011). With this compelling research, there is evidence to suggest virtual dissection is as effective in learning outcomes as physical dissection.

In order for health science courses to be offered online, institutions must find a way to incorporate similar as well as quality dissections that occur in virtual labs. There is evidence to support physical dissection is effective over virtual labs just as there is evidence to support there are effective modalities in virtual labs that parallel physical dissection labs. This topic needs further examination to gain a deeper understanding of physical dissection and virtual lab dissection.

Learning Outcomes

The first stage of UbD is Identify Desired Results. In this stage, the instructors are determining the desired levels of achievement in learning outcomes that students should achieve by establishing criterion such as goals, outcomes, and objectives (Wiggins & McTighe, 2005). By determining desired levels of achievements in learning outcomes, the instructors ensure the *transfer of learning* in students (Wiggins & McTighe, 2005). The desired outcomes stem from inquiry based outcomes in which the learner is gradually building upon. Constructivism evidence is found in the outcomes as they often use action verbs such as *apply* or *explain* which is more of an active style of learning (Wiggins & McTighe, 2005). For the purposes of this study, the desired results will be called learning outcomes.

Learning Outcomes Context

Learning outcomes originated from outcomes-based education. This educational practice began in the 1980s as means to direct course development and competencies, and later in the 1990s, as a means to measure learning (Douglass, Thomson, & Zhao, 2012). Learning outcomes provide insight to the educator based upon a measurable construct (Webber, 2012). Learning outcomes are rooted in replication of material by continually examining the same phenomenon with different methods (Sussman & Dutter, 2010). Learning outcomes are commonly created and established in higher education by the faculties and administrators pertaining to the course, and some are used by accrediting bodies and institutions to standardize curriculum and learning outcomes (Douglass et al., 2012; Wiggins & McTighe, 2005). Learning outcomes assists educators in determining if a student was successful or not successful in their learning. Often learning outcomes are measured by a predetermined measurable construct in the form of an assessment (Maclellan, 2004). Therefore, by establishing learning outcomes first, the instructors can create course content based upon these items to ensure the learning outcomes are achieved (Wiggins & McTighe, 2005). Learning outcomes are a valuable tool to measure learning in students in both face-to-face and online learning modalities.

In appearance, face-to-face learning and online learning are completely different in their approach to achieving learning outcomes. Technology may change the medium in which information is transmitted, but the content is the same (Gumport & Chun, 1999). Quality of online technology applications in online education is vital for successful teaching and student learning (Li & Liu, 2005). However, online technologies themselves do not improve learning outcomes (Bonvillian & Singer, 2013). In face-to-face learning, students have access to course content and course learning in a physical classroom. However, online learning students have access 24/7 to learning material via their learning management system and technology which encourages and equips them with the information that can be repeated and easily accessed at any time or any day (Koutsabasis et al., 2011). This is conducive and corroborates student-centered learning which is a characteristic of online learning.

Online and face-to-face education share the same core foundation, which is achieving learning outcomes through theory based course design and the commonality of course content principles. The end result of both modalities is education and student learning outcomes, but how each modality achieves this end result is the difference (Barbera, 2004). This difference from face-to-face to online learning isn’t automatically all negative, and it doesn’t necessarily mean one is better than the other. The difference is simply in each of their approaches to achieving education and student learning outcomes. This research study compares the learning outcomes in face-to-face and online learning.

Comparing Online and Face-to-Face Learning Outcomes

A common concern with online learning is if the levels of achievement in learning outcomes are equivalent to face-to-face learning (Ma & Nickerson, 2006). The literature finds that there are three categories of learning outcomes when comparing online and face-to-face: no significant differences in face-to-face to online learning, significant differences in learning outcomes with face-to-face being more effective, and significant differences with online learning being more effective. This section will examine the literature comparing learning outcomes of face-to-face and online learning.

No significant difference. In a study comparing online learning to face-to-face learning, Olson and Wisher (2002) did not find significant differences in the levels of achievement in learning outcomes. A meta-analysis study by Ma and Nickerson (2006) further supported no significant differences in learning outcomes when comparing online science labs and face-to-face science labs. Neuhauser (2002) also found no significant differences in learning outcomes with 96% of participants agreeing the online course was as or more effective than the comparable face-to-face course.

A frequently cited resource for no significant differences when comparing online and face-to-face learning outcomes is Thomas L. Russell's (2001) comparative research study. Approximately 355 research studies were summarized in this body of research that supported no significant differences between these two modalities of learning. More recently, in a study by Sussman and Dutter (2010), there was no significant differences in levels of achievements in learning outcomes when comparing the learning modalities of face-to-face learning to online learning. The findings of these studies offer more validation supporting no significant difference in learning outcomes when comparing online learning and face-to-face learning. Collectively, they suggest there are other factors outside of the modality of learning that affect levels of achievement in learning outcomes of online learning.

Significant differences in higher online learning outcomes. Some studies resulted in online learning achieving higher levels of achievement in learning outcomes compared to face-to-face learning. Studies by Mottarella et al. (2004) suggested students in a physical classroom which utilized online technologies had significantly higher grades than students in online learning. Additionally, Salter, Vale, Sanfilippo, Loh, and Clifford (2014) found e-learning resulted in the highest retention after 7 months in comparison to face-to-face learning. A meta-analysis of 99 studies conducted by the U.S. Department of Education (2010) from 1996 through 2008 revealed learning outcomes for students enrolled in online learning were higher than students of comparable face-to-face learning. In further support, Koutsabasis et al. (2011) determined student comprehension increased with asynchronous online learning. In fact, a meta-analysis study by Shachar and Neumann (2010) found 65% of online learning students in 86 studies had outperformed their face-to-face learning counterparts.

Some of the most compelling evidence for significant differences comes from Means et al.'s (2009) research of more than 1000 studies. Their research revealed online learning is slightly more effective on average than face-to-face learning. More research of compelling evidence is from a meta-analysis study of more than 20,000 participating students from 125 studies during the years 1990-2009 from Shachar and Neumann (2010). This data revealed 70% of the studies demonstrated online learning students outperformed face-to-face learning students. It is evident there is a large amount of research showing online learning results in higher academic achievement in learning outcomes.

Significant differences in higher face-to-face learning outcomes. Other studies contradicted the findings of online learning students outperforming face-to-face students. Garman (2012) found grades were significantly higher in a population of over 4,000 face-to-face students when compared to over 2,000 online students in lecture, lab, and final grades of a biology course. In further support, Emerson and MacKay (2011) determined students who learned lessons using paper and pencil increased their performance by 24% over students who used technology for online learning. Also, Hughes (2000) found students in face-to-face labs performed higher on delayed post-tests than online labs which suggested online labs retention resulted in shallow learning of the material.

Analysis of the review of literature supports no significant differences, higher outcomes in online learning, and higher outcomes in face-to-face learning. There is ample supportive evidence to suggest online learning is as effective as face-to-face learning. In this research study, the learning outcomes will be equivalent in the two learning modalities of face-to-face learning and online learning. This is to ensure the participants will have equal opportunity to achieve the learning outcomes. Therefore, the purpose of this research will further assist in examining the levels of achievement in learning outcomes in face-to-face learning and online learning.

Assessments

The second stage of the process is "Determine Assessment Evidence." The purpose of this stage is to determine the various assessments in which students will apply their learning to achieve the desired levels of achievement in learning outcomes (Wiggins & McTighe, 2005). This is established through the six facets of stage two in UbD: explain, interpret, apply, perspective, empathy, and self-knowledge. These facets guide the development of types of performance tasks and various assessments such as quizzes, exams, observations, and work samples (Wiggins & McTighe, 2005). Constructivism is evident here as learners demonstrate their knowledge through a holistic assessment process (Dick, Carey, & Carey, 2009). The performance tasks and assessments are reflective of the learning outcomes established in stage one.

Exam Assessment

The major purpose of assessments is to determine if students have achieved a particular standard by demonstrating their abilities (Shephard, 2009). Due to the relatively newness and unforeseen trajectory of online education, educators and researchers are unaccustomed to applying face-to-face learning assessments of quality to online learning assessments. Moreover, online education must set the same quality expectations and learning experiences as face-to-face education (Jacobs, Doyle, & Martin, 2013). The conventional view of assessments is evaluating student comprehension of instructed material, but this definition has evolved to be more 'learner-centered' which is rooted in constructivist theory (Webber, 2012). The newer definition defines assessments as designed activities to foster learning by the student that yields information for evaluating a learner's abilities and skills (Webber, 2012; Wiggins & McTighe, 2005). This modern definition supports the learner-centered approach to online learning. There is a lack research on quality assessment in online learning, and the research that does exist is lacking parallels. This research study will not focus on quality assessments. In this study, an assessment will be used to measure learning outcomes. Assessments for learning outcomes can take on many forms, and the learning outcomes assessment used in this research are exams.

Performance Tasks

Assessments provide crucial insight to assess learning, but it only examines one aspect of learning. Another valuable factor in understanding learning, is examining students through performance tasks such as surveys (Eom et al., 2006). Reflection through survey has been found to have a strong correlation to conceptualization and positive learning experience which has an influence on one's learning experience (Sobral, 2000). In this research, the survey focuses on perception of learning and satisfaction of students.

The second stage of UbD is important in constructing assessments and performance tasks to support the defined learning outcomes of stage one. In this research, the assessment supporting the learning outcomes will be exams and the performance task will be a survey. The exams will be reflective of the learning that occurred during the lab. The survey will support reflection of student perception of learning and satisfaction after the completion of the labs.

Student Learning

The final stage of UbD is "Plan Learning Experiences and Instruction." This stage is when instructors support the desired levels of achievement in learning outcomes established in stage one and the assessments and performance tasks of stage two by developing authentic instruction and learning (Wiggins & McTighe, 2005). Instructing online learning is quite different than instructing traditional learning. Instructing online learning requires an acquisition of technological skills and proficiency in operating computers and LMS. Online learning curriculum establishes what to instruct in online learning, but it does not construe how to instruct it (Green et al., 2010). Online learning forces students to contextualize their learning by merging their cognitive learning with experiential learning creating the "student-centered" approach which is rooted in Constructivist theory (Anderson, 2008; Huang, 2002; Mashaw, 2012). For the purposes of this research, the focus in the final stage will be on the learning and not the instruction by educators. Therefore, this section is reflective of student learning and will focus on the core similarities of online learning and face-to-face learning as well as distinguish the core differences.

Core Similarities

In 1987, Chickering and Gamson established the criteria that makes an effective higher education course, and these principles have been applied to online learning (C. Graham, Cagiltay, Lim, Craner, & Duffy, 2001). The principles of good practice in higher education courses are: encourages contacts between students and faculty, develops cooperation among students, uses active learning techniques, gives prompt feedback, emphasizes time on task for deadlines, communicates high expectations, and respects diverse talents and ways of learning (C. Graham et al., 2001). These principles are reflected in Johnson and Aragon's (2003) pedagogical model of principles that are critical for quality online learning. These principles are: address individual differences, motivate the student, avoid information overload, create a real-life context, encourage social interaction, provide hands-on activities, and encourage student retention. This pedagogical model reflects the instructional methods and learning theories of online learning (S. D. Johnson & Aragon, 2003). Many studies have contributed to the development of instructing online with strong technological support for creating a learning environment conducive for engaging activities to enhance student learning (Stuckey-Mitchell & Stuckey-Danner, 2007). Educators in online learning utilize a LMS to encourage social interaction that would normally occur in a face-to-face setting by using discussion boards, for example. Online educators work to create virtual connections to students in order to motivate them and encourage them in their learning as online learning students lack physical presence with educators. Since online learning occurs at the student's discretion, the content is designed to reflect real-life and avoid over-whelming the student with only lecture. The content is typically interactive which encourages hands-on action and appeals to many different types of learners.

Both modalities of the same subject should be aligned to deliver similar learning experiences and learning outcomes (Bonvillian & Singer, 2013; Mashaw, 2012). Even though instructor and student do not share immediate space, the process of education should be the same by employing sound assessment practices, measures to authenticate instruction, and alternatives to face-to-face interaction (Milam et al., 2004). Online learning is similar to face-to-face, yet there are differences in learning.

Core Differences

Due to the fundamental elements of online learning, it has contrast when compared to face-to-face learning. Face-to-face learning is delivered in an environment, typically a classroom, in which the instructor and students are physically present and interacting in real time (Gumport & Chun, 1999; Haigh, 2007). Online learning is delivered through software technology in the form of a learning management system (LMS) where the instructor and the students are virtually present and interacting via online technology (Green et al., 2010). Online learning incorporates the application of technology in the form of a computer, tablet, or smartphone device with access to the internet and the LMS (Koutsabasis et al., 2011; Tobin, 2014). Face-to-face learning depends far less on technology than online learning.

The most prominent feature that drives students to enroll in online learning is the ability to access the course from anywhere and the discretion to access it when he or she chooses (Kelly, et al., 2009; Rickard, 2010). Online learning permits a student to work at their preferred pace and be in control of their learning (Kenny, 2002). This is especially enticing for non-traditional students who may have factors such as a family, job, and location bound obligations that prevents the student from attending a brick and mortar classroom (Hart & Morgan, 2010). It enables students to balance family life, time, and school in a method that is conducive for their life (Blackmon & Major, 2012). Online learning is much more convenient for students (Koutsabasis et al., 2011; Okech, Barner, Segoshi, & Carney, 2014). Unlimited access to course content online encourages the students to use it without the restrictions that accompany face-to-face learning (Kelly et al., 2009). Online learning allows students to be in control of their learning (Leonard & Guha, 2001). In contrast, face-to-face mandates a student attend a brick and mortar classroom on a specific date and time, and instruction occurs in the classroom. Therefore, the student is not in control of the timeline when he or she learns. Since online learning students learn at their own discretion, they have a different set of responsibilities to manage in order to be successful with online learning. Blackmon and Major (2012) suggested students of online classes put the onus on themselves to learn and have some responsibility for the course outcomes. This corroborates "student-centered" learning which is evidence of constructivism.

Stage three of UbD relates to instruction and student learning. Face-to-face and online learning share similarities in student learning design, but share core differences in application of technology and access to course content. In this study, participants will experience an anatomy dissection lab face-to-face and online. The student learning outcomes and instruction will be the same in both modalities of the lab, and the differences will be technology and access to the course content. This research will focus on student learning in reflection of learning outcomes.

Perception of Learning and Satisfaction

A large amount of research has been performed in regards to the phenomenon of student perception of online learning. Research on perceptions can provide insight and valuable information that is not directly observable such as the experience that has occurred and how the experience was processed by the student (Bakx, Van Der Sanden, Sijtsma, Croon, & Vermetten, 2006). Often perception is researched in the form of a survey, and this entails reflection by the student about one's experience (Sobral, 2000). A survey will be used at the end of this research to examine perception, specifically examining learning and satisfaction in students after experiencing both face-to-face anatomy dissection and online anatomy dissection. For the purposes of this study, student satisfaction is included with the student perceptions of online learning because student satisfaction of online learning is often inquired about in perception of learning surveys (Eom et al., 2006). Therefore, the survey is reflective of both perceptions.

Student Positive Perception

In the research that has been conducted, there is positive perceptions of online learning in students. Online learners were found to be satisfied and successful when they were responsible for their learning and made themselves present in the online course (Shin & Chan, 2004). Iverson et al.'s (2005) research indicated online learning students have a more positive reaction to enjoyment and utility in online learning even though online learning students found online learning to be more difficult. Lin's (2007) research established student user satisfaction and behavior in online learning was directly linked to the information quality, accuracy, timeliness, and usefulness of the online course. Chen and Chuang (2012) found favorable perceptions from research of over 100 students enrolled in an online nursing program. They claimed online exams were favorable for their accessibility, immediate feedback, and user-friendly operations.

When a sample of 44 online learning students were asked if they learned as much in online as they did in face-to-face learning, the results found 42% agreed they had learned as much and 42% disagreed (Leonard & Guha, 2001). The same research resulted in 75% of their sample of students that were satisfied with their online experience, and the same percentage found the course met their expectations of online learning. These findings indicate students are in general satisfied with online learning. In further support, Richardson and Price (2003) research of over 250 students found 75.9% of students were highly satisfied with the quality of their online course. Student satisfaction in this research was strongly associated with students receiving quality learning materials, clear goals outlined, and established standards in their online learning course. This indicates there are other influences in students' positive perceptions of online learning.

These perceptions suggest online learning is a positive experience for students enrolled in online learning. In online learning, students are responsibility for their learning and feel as if their learning experience is as effective online as it would be in a face-to-face classroom.

Student Negative Perception

It seems the most dissatisfaction with online learning is comfort with technology and issues with technology. When students who were uncomfortable with technology enrolled in online learning, the students perceived online learning more negative in research from Simpson and Benson (2013). Shin and Chan (2004) collected questionnaires from 285 participants. They determined students' self-assessment of technology comfort and internet skills were the strongest variables affecting perspective of online learning. Technology and internet issues which can prevent students from successful access as well as prevent students from working on academic work are the biggest issues with online learning according to research done by El Mansour and

Mupinga on 41 student participants (2007). Computer issues can detract from student learning in online learning (Kenny, 2002). It is apparent online students need to have a high level of comfort in operating technology and dependable technology with internet connection in order to have a positive experience in online learning.

Learning about student satisfaction in online learning was the focus of the research performed by Palmer and Holt (2009). The university in which the research occurred required all the students to take at least one online course, and researchers wanted to gauge perceptions of the students studying in these online courses. Out of the 5,862 students surveyed, responses from 761 participants were received. The results revealed students were most displeased with the lack of interaction with other students and communication in a face-to-face environment (Palmer & Holt, 2009). In a study of 370 medical students, C. R. Davis et al. (2014) found 91% disagreed that they learned more from virtual labs than from face-to-face labs. Students were adamant about the application of cadavers for learning with over 90% of participants agreeing that seeing dissected anatomy specimens is essential for learning anatomy (C. R. Davis et al., 2014). A crucial question in the survey inquired if the students were satisfied with the wholly online delivery of the course, and the results concluded that over 33% of respondents were unsatisfied with the learning outcomes connected to online learning. This was a major revelation, as it was believed more students relished in online learning. In further support of this, Haigh (2007) found 8% of face-to-face graduate students agreed that online and face-to-face learning were equal and 7% of face-to-face undergraduate students agreed the modalities were equal. There is supportive evidence revealing learning in an online modality is not a satisfactory experience for all online students, and a large amount of students find it unequal when compared to face-to-face learning.

There is depth of research on student perception of online classes. Student perspectives are equally negative and positive. As a result, there is no agreed upon perception of online learning in students. However, there is a void in research in examining health science students' perceptions on virtual anatomy dissection labs in comparison to face-to-face anatomy dissection labs. These perceptions are vital in influencing future instructions of online science courses with virtual anatomy dissection labs.

Summary

The review of literature is reflective of common themes found in research such as online learning, learning outcomes, assessments, student learning, and perception of learning and satisfaction. There is a lack of research specifically examining online science courses with accompanying virtual labs in health science students. The purpose of this research will contribute to the literature by comparing higher education health science students' levels of achievement in learning outcomes in face-to-face anatomy dissection labs and virtual anatomy dissection labs. There is a small amount of research focused on comparing these two modalities of student learning. This study will also examine perception of learning and satisfaction in health science students. Perception of learning and satisfaction in health science students is lacking. Therefore, this research study serves to contribute to the depth of research of achievement of learning outcomes in health science students in face-to-face and online learning modalities and perception of learning and satisfaction of health science students.

CHAPTER III: METHODS AND PROCEDURES

The purpose of this research was to compare the levels of achievement in learning outcomes of face-to-face anatomy dissection labs and online anatomy dissection labs through common learning exams. The literature review reveals paucity in research of online anatomy dissection labs using objective measures such as exams. In addition, research is lacking using health science students as participants. An additional component of the study was examining student perceptions of learning and satisfaction of online anatomy dissection labs through a personal assessment survey. This section will outline the research design, data gathering tools, data analysis plan, and data quality measures.

Research Questions

The study addressed the following research questions:

1. Do levels of achievement in learning outcomes differ on examinations for undergraduate health science students when using a face-to-face dissection lab compared to an online dissection lab at a private Midwestern university?
2. What are undergraduate health science students' rated perceptions of learning and satisfaction of online anatomy dissection labs at a private Midwestern university?

Research Design

A quantitative study was chosen for this research based upon the researcher's previous experience and the supportive design of quantitative research for this study. This method was appropriate for this research as two comparable populations were identified, and both received the treatment through the research design (Trochim, 2006). Quantitative research tests for the impact of a treatment on an outcome (Creswell, 2014). The research design was an experimental, equivalent group design as the population was randomly assigned into two groups

(Creswell, 2014; Trochim, 2006). Random assignment is considered possible as the researcher randomized the common pool of participants using a randomizing tool.

There were two data collection tools used in the research: three exams and one cross-sectional survey. The three exams consisted of one pre-test and two posttests. An assessment was preferred in this study because it is an objective measure of learning outcomes allowing for comparison of two populations (Creswell, 2014). The cross-sectional personal assessment survey used to gain perceptions of learning and satisfaction of the online anatomy dissection lab was adapted from a similar tool reported in the literature (Kelly et al., 2009; Mathiowetz et al., 2016; Rehman et al., 2012). The design of this type of survey serves to identify attributes of the sampling population in order to gain inferences and collect descriptive data on health science students (Fowler, 2009). These two tools served as the data collecting tools in this research.

The design of the study was a two-group switching replications design. This is one of the strongest types of experimental designs (Trochim, 2006). This was a two-group design with three types of measurement (Trochim, 2006). For the first unit, one group was the control face-to-face anatomy dissection lab group, and one group was the experimental online anatomy dissection lab group. These conditions were switched in the second unit, and thus, all students participated in both lab groups thereby receiving both treatments (Trochim, 2006). The control group was the face-to-face anatomy dissection lab group. The experiment can be represented based upon the image in Figure 1. The letter R represents random assignment, letter O represents a measurement or observation using a recording instrument, and letter X represents exposure of the group to the experimental condition (Creswell, 2014).

R	O	X	O		O
R	O		O	X	O

Figure 1. Switching Replications Design. This figure illustrates the design of this research study.

The independent variable was the instructional modality with the online dissection lab being the experimental condition, and the face-to-face dissection lab being the control condition. All participants took a common pre-test before participating in the experiment represented by the first letter O. Then all participants participated in one unit with one group being exposed to the experimental condition, represented by the first letter X, and the other group in the control condition. At the end of the unit, there was a common posttest denoted by the second letter O. This process repeated a second time, but the groups were switched so that both groups were exposed to the experimental condition (Trochim, 2006). The dependent variable was the scores of the two units with two common posttests.

After the completion of the second posttest, all participants experienced face-to-face dissection labs and online dissection labs. The cross-sectional survey was taken on the internet immediately following the completion of the second posttest.

Population

The sample was derived from a private health science university in the Midwest. The institution was selected because the students were considered to be health science students, and there were supportive lab tools and equipment needed for this research study. The population of students at the university was 88% female and 12% males with 84.8% White, non-Hispanic, 6.1% Black or African American, 3.2% Hispanic/Latino, and 3.0% Asian.

This study was conducted in an undergraduate semester long anatomy course with an accompanying anatomy dissection lab. There were two sections of the course offered during the time frame of the research, and the researcher was the instructor for one of the sections of the course. The course was a 100-level course required by all programs, and it was a prerequisite for many advanced courses. The semester long course met for 160 minutes of lecture and 105 minutes of lab each week. Based on the institutional course procedures, the course was described based on course description and course outcomes as follows:

Course Description: This course offers basic concepts in human anatomical structures. It includes all major body systems with emphasis on histological, developmental and gross anatomy. The accompanying lab will reinforce lecture through animal dissection and human prosection.

Course Outcomes:

1. Master terminology to effectively communicate information that reflects an understanding of the human body.
2. Understand the foundations of the body from the levels of cell, tissue, organ, organ systems, to organism.
3. Recognize the form and function of anatomical structures in each instructed system.
4. Explain the intrarelationships and interrelationships of the anatomical structures in the human body as it functions as a single functioning organism.
5. Synthesize and apply knowledge to connect the anatomy of the human body as it relates to other disciplines.
6. Demonstrate proficiency in anatomical laboratory procedures and specimen examination.

All the students enrolled in the course were health science students and either first or second year students. The participants were diverse in ethnicity, age, sex, and academic levels of achievement. Due to the lack of research on health science student populations, this health science population was appropriate for this research. Participants were verbally asked to volunteer to be in the study, and no incentive was provided to participate. In order to minimize coercion, volunteers were given the option to not participate without any consequences. Volunteers signed a consent form and met the inclusion criteria in order to participate.

Sampling

This convenience sample (Creswell, 2014) included two sections of a human anatomy course with an accompanying anatomy dissection lab resulting in two groups of students. These two groups were randomly assigned to the face-to-face anatomy dissection lab and the online anatomy dissection lab. The total number of students eligible was 71. Eligibility criteria included voluntary participation and signing a consent form.

Inclusion criteria included students enrolled in the human anatomy course at the Midwestern university. Exclusive criteria included having taken a cadaver based human anatomy course prior, inability to read and write in English, and inability to follow directions and procedures. In total, 34% (N = 24) of students recruited agreed to participate in the study. The students were given the option to not participate in the study. The procedures utilized in this research were reviewed and approved by the university's institutional review board.

Setting

The sample came from students enrolled in the human anatomy course with the accompanying anatomy dissection lab at a private Midwestern health science university. The university is located in a small city with an area population of over 300,000. The university has over 700 full and part-time undergraduates. A small amount of students equaling 5% live on campus, while the other 95% of students commute. The data gathering occurred in the human anatomy lab at the institution for the students enrolled in face-to-face dissection lab, and the data gathering occurred at a computer of the student's choice for the students enrolled in the online dissection lab. The labs at the institution are modern with up-to-date tools and equipment including a modern cadaver lab that supports the anatomy learning at the university.

Data Gathering Tools

In this research, three examinations were used. The exams contained multiple choice questions and were 15 questions in length (see Appendices A, B, and C for exam questions). The researcher developed the examinations using input from other anatomy faculty members from the university as well as test banks offered by the textbook company. The pretest included questions pertaining to the level of knowledge in identifying human anatomy structures of blood vessels and nervous system structures (see Appendix A). The first unit posttest (see Appendix B) was identifying and explaining identified anatomy structures based on blood vessels (e.g. "identify the blood vessel indicated"). The second unit posttest (see Appendix C) was identifying and explaining identified structures based on the nervous system (e.g. "identify the neuron indicated"). No use of any resources was permitted to be used during the exams. The examinations were reflective of the established aforementioned course outcomes of numbers 1, 3, 4 and 6. All questions were data gathering questions.

There was also a perception of learning and satisfaction survey that all participants completed after the second exam had been taken. The survey consisted of 32 items with 22 pertaining to self-perceived learning and 10 pertaining to self-perceived satisfaction (see Appendix D for survey). This survey was an adapted tool from the literature review regarding attitudes in health science students to alternative lab instruction modalities (Kelly et al., 2009; Mathiowetz et al., 2016; Rehman et al., 2012). All questions were data gathering questions. Each question was answered using a Likert scale that was supported through commonly used perception surveys. For the self-perceived learning and self-perceived satisfaction questions, the scale was a five-point Likert scale as follows:

1 - "Strongly disagree"

2 – "Disagree"

3 – "Neither agree or disagree"

4 – "Agree"

5 – "Strongly agree"

The use of a five-point Likert scale was supported by currently used perception surveys. Though these perception surveys were not used for this research, support for the Likert scale as a means to gain student perception can be found with these two frequently used surveys: the Panorama Student Survey and the Student Instructional Report II (SIR II). The Panorama Student Survey was developed by Panorama Education and the Harvard Graduate School of Education in 2014 (Panorama Education, 2015). The survey uses a five-point scale with questions that measure students' perceptions of learning in addition to other items (Panorama Education, 2015). The survey scale has gone through extensive and ongoing analysis with a large amount of data to support the validation of the survey scale (Panorama, 2015). Education Testing Services (ETS) developed the Student Instructional Report II (SIR II) that uses a five-point Likert scale to measure perception of learning (J. Centra, 2006). The survey scale used in this survey was validated through a factor analysis (J. Centra, 2006), and it was an adaptation of these two validated perception survey scales.

Data Gathering Procedures

The researcher asked for volunteers based upon the two sections of human anatomy to participate in the research. The researcher was the instructor for one of the two sections. Volunteers were contacted by the researcher. In order to minimize coercion, another human anatomy faculty member was present when the researcher asked for participants in both sections of the human anatomy course. Each participant signed a written consent form (see Appendix E) and met the inclusion criteria for participation.

During week one, all participants in the two groups were given the pretest in a face-to-face setting using paper and pencil (see Table 1 for timeline). The pretest occurred at a designated date and time in which the participants attended. The pretest was in the same format as the two posttests, which was a 15-question multiple choice test.

Two weeks later during week three, the groups were divided into a face-to-face group and online group. Each group watched a presentation based on blood vessels in the first unit. The presentation was developed by the researcher with support from other human anatomy instructors. Each presentation was a pre-recorded 20-minute presentation using Tegrity software and was the same for both the face-to-face and online group. The face-to-face anatomy dissection lab presentation was recorded as the instructor presented the information, and then this recorded presentation was the same presentation viewed by the online anatomy dissection lab (see Appendix F). Therefore, the face-to-face group was presented the presentation in a physical classroom, and the online group watched the presentation online with each group receiving the same presentation. The pre-recorded presentation was implemented in order to minimize differences of instruction in the two modalities. The Tegrity recorded presentation utilized a PowerPoint for course content material and was available for all students in electronic and paper versions. The instructor was available for questioning in person for the face-to-face group and through email for the online group.

During the face-to-face dissection lab of week three in the first unit, the group observed the presentation in the human anatomy laboratory classroom at a specific time at the institution. Following the pre-recorded presentation, students had 85 minutes of free use of laboratory time. The specimen utilized in the face-to-face dissection lab was the human cadaver.

During the online dissection lab of week three in the first unit, the online group observed the pre-recorded presentation during a designated window of availability in which the lecture was available. The online group watched the presentation on their own time and at their own convenience within the window of availability. The specimen utilized in the online group was a virtual human cadaver via a virtual simulation learning system, *Anatomy and Physiology Revealed*.

The common posttest occurred one week after the laboratory session during week four (see Appendix B). The first unit posttest was based on the topic in the Tegrity presentation. Each group completed the common posttest in their respective modality. This means when in the face-to-face dissection lab, the students completed the posttest in the human anatomy laboratory classroom. When in the online dissection lab, the students completed the posttest online within a designated window of availability.

There was a one-week break between the end of the first unit and the beginning of the second unit. In the second unit during week six, the process repeated itself exactly except that the groups were switched. The face-to-face group in the first unit was the online group in the second unit, and the online group in the first unit was the face-to-face group in the second unit.

The presentation in the second unit occurred during week six using the Tegrity recorded presentation over brains and neurons. The presentation was the same for both groups with the face-to-face presentation being presented in a physical classroom and being recorded in order for the online group to view the same presentation, but in an online format (see Appendix G). During week six, the face-to-face lab group observed the presentation in the human anatomy laboratory classroom at a specific time at the institution and students had 85 minutes of free use of laboratory time. The online group observed the pre-recorded presentation during a designated window of availability and watched the presentation on their own time and at their own convenience.

The second unit common posttest based on brain and neurons occurred during week seven (see Appendix C). Each group completed the second unit posttest in their respective modalities. Finishing the second unit, all participants had been in a face-to-face dissection lab and an online dissection lab as well as completed a posttest in both modalities. Data from the two posttests and one pretest were collected resulting in ratio data for analysis. Below is Table 1 showing the timeline:

Table 1

Timeline for Research Study

Weeks	Group	Group
Week 1	Pre-test	Pre-test
Week 3 (First Unit)	Face-to-Face Blood Vessel Presentation and Lab	Online Blood Vessel Presentation and Lab
Week 4 (First Unit)	Face-to-Face First Unit Posttest	Online First Unit Posttest
Week 6 (Second Unit)	Online Brain, Neurons Presentation and Lab	Face-to-Face Brain, Neurons Presentation and Lab
Week 7 (Second Unit)	Online	Face-to-Face

Second Unit Posttest Survey- Online	Second Unit Posttest Survey-Online

Immediately after completion of the second posttest during week seven, participants completed the survey (see Appendix D). Both groups took the survey on the internet using a survey maker tool, Quizmaker.com. Data from the survey was collected by the Likert scale questions resulting in the ordinal data. All information that was used in the data analysis was derived from the three examinations and survey.

Data Analysis Methods

The analysis compared the level of achievement in learning outcomes by comparing the results of whether or not the students met the learning objective of the exams from the two groups. The purpose of the pretest was to determine the knowledge base of the participants, and the two posttests purpose was to determine if actual learning occurred during the two units by comparing the scores. Data analysis focused on comparing the outcomes of the exams by applying statistical analysis of one-way analysis of variance (ANOVA) with a post-hoc tukey. The purpose of an ANOVA is to compare the means of two or more groups on one dependent variable to see whether the means are significantly different (Urdan, 2010). Data analysis was completed using Statistical Product and Service Solutions (SPSS) PC version, and setting the level of significance at $p = .05$.

For the survey analysis, data was analyzed using a Pearson correlation coefficient with a level of significance at $p = .05$. Table 2 presents the analysis used on the assessment tools to answer a specific research question.

Table 2

Assessment Tools and Method of Analysis for Research Questions

Assessment Tools	Method of Analysis	Name of Analysis	Research Question
Pretest	Comparison of total mean scores to Posttest 1 and Posttest 2	One-way ANOVA	Question 1
Posttest 1	Comparison of total mean scores to Pretest and Posttest 2	One-way ANOVA	Question 1
Posttest 2	Comparison of total mean scores to Pretest and Posttest 1	One-way ANOVA	Question 1
Survey	Analysis by question	Pearson correlation coefficient	Question 2

Data Quality Measures

The reliability of an assessment is the degree to which the tool produces consistent and stable results (Trochim, 2006). Reliability of the exams was determined through test-retest reliability, and reliability of the survey was determined by analysis of internal consistency using Cronbach's alpha. The test-retest reliability and reliability of the survey was performed by a group of former students.

The exams that were utilized in this research were not standardized tests. These exams were, however, utilized at the institution and the questions were adapted from a textbook test bank. The survey that was used was adapted from previous statistically accepted outcome measurement tools referenced in literature (J. A. Centra & Gaubatz, 2005; Kelly et al., 2009; Rehman et al., 2012). There was a limited amount of perception of learning and satisfaction surveys in the literature. Therefore, the survey that was used in this research was unique to this study, but the Likert scale was a commonly used survey scale. Face validity and construct validity of the exams and survey were achieved by including other anatomy instructors that reviewed the pre-recorded lecture, the survey, and the exams to ensure the assessments were valid and pertained to the intent of the research.

There were potential threats to validity. The first potential threat was mortality or loss of participants from a group. A loss due to mortality can change the makeup of a group and skew the results (Creswell, 2014). Due to the length of this research, it was possible participants may withdraw from the research. For this reason, any participant that withdrew was removed from the data.

There was also a threat to diffusion of treatment. With the participants being from the same institution and same course, there was a potential threat that participants would communicate with each other and could influence the outcomes of the exams. Efforts to minimize this was taken.

Another threat was selection bias as the participants were a convenience sample from the Midwestern university. Therefore, the sampling was not a true random sampling. This may have affected results of the outcomes since the population of student demographics may not be a representative of other private universities.

Ethics

Approval for the study was required from College of Saint Mary Institutional Review Board (IRB). An application was completed in August 28, 2016. Formal IRB approval was granted on October 3, 2016 (see Appendix H). The research was approved by the IRB after a successful presentation of the research questions, significance, and relevant literature review.

Additionally, the institution in which the research occurred had a IRB process. An application was completed for IRB in October 6, 2016. Formal IRB approval was granted on October 7, 2016 (see Appendix I).

The participant's rights were upheld, and the researcher disclosed any possibility for mental, physical, or emotional harm. The researcher completed the Protection of Human Rights Certificate. Permission was obtained through a voluntary consent form. The participants were not compensated. A consent form and information letter can be found in Appendix E. Data collected was secured through confidential files on a password protected computer in an office that was locked. Data will be held on to for seven years. Participants in this study signed an informed consent letter in order to participant in the research.

Summary

This quantitative research utilized two sections of human anatomy course and randomly assigned them into two groups. The design of this research was a two-group switch replication design in which the two groups both experienced the treatment conditions. There was a total of three common exams to measure learning outcomes: a pretest and a posttest exam after each of the two units. A survey was used to examine the perception of learning and satisfaction in the participants after the end of the second unit. Data gathering tools and data analysis tools were outlined as well as data quality measures. Data analysis is detailed in chapter 4.

CHAPTER IV: RESULTS

The purpose of this study was to compare the levels of achievement in learning outcomes of face-to-face anatomy dissection lab to online anatomy dissection lab in a population of health science students. The learning outcomes of anatomy dissection were established using UdB criteria in step one of identifying desired results (Wiggins & McTighe, 2005). By identifying the desired results, the learning activities and outcomes are designed to meet those results (Wiggins & McTighe, 2005). This supports the backward planning framework to improve student learning outcomes. In addition, the study examined outcomes of a personal assessment survey by the student on perception of learning and satisfaction using a 5 point Likert survey instrument. Gaining information from the survey was significant for deepening an understanding of student perceptions of online learning and future course offerings.

Overview of Study Design

A sample of 71 students from a private Midwestern university human anatomy class with an accompanying lab were asked to participate in the research study. There were two sections of the human anatomy class, and the researcher was the instructor for one of the sections. Two types of data collection tools were used in the research: classroom exams (three) and a survey. One of the three exams was a pretest in a paper form that all participants completed in a face-to-face environment. A second exam was a posttest that was completed in paper form when the participants were in the face-to-face anatomy dissection lab group. A third exam was a posttest exam that was completed online when the participants were in the online anatomy dissection lab group. Therefore, each group completed a posttest exam in a face-to-face format and an online format. The personal assessment survey data were collected electronically through a survey posted at Quizmaker.com

The data were entered into a spreadsheet, recording the scores for the pretest, two posttests, and the survey. The data were analyzed to compare the pre-test to each of the post-tests, compare the post-tests to each other, and analyze the survey data. This chapter will address the results of each research question.

Participants

The research group consisted of two sections of a human anatomy course from a private Midwestern university. Each of the two sections was instructed by a different instructor with the researcher being one of the two instructors. With a total enrollment of 71 students between both sections, there were 48 in the section not instructed by the researcher and 23 in the section instructed by the researcher. A total of 31 participants initially volunteered to participate with 24 students finishing the research. From the section of 23 instructed by the researcher, 21 volunteered to participate initially with 16 finishing the research. From the section of 48 not instructed by the researcher, ten volunteered to participate initially with eight finishing the research. Data collected from participants who did not finish the research were removed from the data pool.

Analysis of Research Questions

The data were analyzed and used to address the proposed two research questions:

1. Do levels of achievement in learning outcomes differ on examinations for undergraduate health science students when using a face-to-face dissection lab compared to an online dissection lab at a private Midwestern university?
2. What are undergraduate health science students' rated perceptions of learning and satisfaction of online anatomy dissection labs at a private Midwestern university?

For the first research question, a one-way analysis of variance (ANOVA) was used to compare the levels of achievement in learning outcomes from the pre-test and two post-test exams. The purpose of an ANOVA is to compare the means of two or more groups on one dependent variable to see whether the means are significantly different (Urdan, 2010). A one-way ANOVA was appropriate in this research, and the statistical significance was evaluated at the .05 level. In this research, significant differences were found when comparing the learning outcomes of all three exams.

For the second research question, the data analysis tool used was a Pearson correlation coefficient to examine perceptions of learning and satisfaction data from the personal assessment survey. A Pearson correlation analysis measures the strength of a linear relationship between two variables (Urdan, 2010). The statistical significance of the Pearson correlation was evaluated at the .05 level in this study. The survey results revealed significant differences.

Research Question 1

Do levels of achievement in learning outcomes differ on examinations for undergraduate health science students when using a face-to-face dissection lab compared to an online dissection lab at a private Midwestern university?

There were three exams utilized in the research. Each of the three exams were composed of 15 multiple-choice questions that were developed from test banks offered by the textbook company as well as input from other anatomy faculty members at the private Midwestern university. Questions were selected based upon the established desired results from stage one in UbD framework *Identify Desired Results* (Wiggins & McTighe, 2005). In this stage, the desired levels of achievement in learning outcomes are determined by the instructor (Wiggins & McTighe, 2005). For example, a desired level of achievement in a learning outcome in this research study was to correctly identify the common carotid artery in the neck when shown the structure. The instructor was the researcher in this study, and therefore, the health science department determined the desired learning outcomes for both topics instructed in the anatomy dissection labs. Both the researcher and the instructor of the other section adhered to the established learning objectives.

The pretest included learning outcomes based upon both blood vessels identification and nervous system structures identification. The pretest was administered during week one with all participants completing the pretest in a face-to-face format on a paper exam. Data were collected and used to compare to the learning outcomes of posttest exams. Table 3 shows the results. A one-way between subjects ANOVA with post-hoc Tukey compared the effect of modality on learning based on levels of achievement in learning outcomes in pretest results, face-to-face posttest results, and online posttest results. There was a significant effect in the modality of learning at the $p < .001$ for the three conditions. Post hoc comparisons using Tukey HSD test indicated each level of achievement on learning outcome was significantly different. The results of the face-to-face posttests and online posttests learning outcomes were significant when compared to the learning outcomes of the pretest. Significance was evident as the posttest learning outcomes were increased. This suggests learning occurred between the pretest and both formats of the posttest.

Table 3

Comparison of Exams Score Means and Standard Deviations

	Pretest		Online Posttest		Face-to-Face Posttest	
	M	*SD*	*M*	*SD*	*M*	*SD*
Blood vessels	4.04*	1.14	9.50*	1.19	11.81*	2.34
Nerves	3.32*	1.11	13.00*	1.16	10.13*	2.53

Note. *$p < .001$

For the first posttest, the learning outcomes were based upon the instructed topic of blood vessels identification. The first posttest over blood vessels was administered during week four with each group taking the common posttest in their respective modality: the face-to-face anatomy dissection lab group completed it in a face-to-face format and the online anatomy dissection lab group completed it in an online format. Since this was a switching replication study, the groups switched the modality of learning for the second posttest. The learning outcomes of the second posttest were based upon the nervous system structures identification. The second posttest was administered during week seven with each group completing the common posttest in their respective modality. Table 3 shows the one-way ANOVA with post-hoc Tukey results for comparing face-to-face and online groups for both the blood vessels and nervous system structures topics. Each difference was significant at the $p < .001$ level. Face-to-face posttest scores for the blood vessels topic were significantly higher compared to the online blood vessels posttest and, contradictory, the online nervous system structures posttest scores were significantly higher compared to the face-to-face nervous system structures posttest.

In summing up the results for research question 1, the data revealed the pretest learning outcomes were significantly different in comparison to the results of the face-to-face posttests and the online posttests learning outcomes. Not surprisingly, both posttest formats for both blood vessels and nervous system structures showed significant improvement compared to their respective pretest scores. When comparing the levels of achievement in learning outcomes between the face-to-face posttests and the online posttests learning outcomes, all the posttests were significantly different. Specifically, face-to-face posttest scores for the blood vessels identification were significantly higher compared to the online blood vessels identification posttest. Conversely, the online nervous system structures posttest scores were significantly higher compared to the face-to-face nervous system structures posttest. Both posttest formats for both blood vessels identification and nervous system structures showed significant improvement compared to their respective pretest scores.

Research Question 2

What are undergraduate health science students' rated perceptions of learning and satisfaction of online anatomy dissection labs at a private Midwestern university?

In this study, the participants were asked to rate their perception of learning and satisfaction on a 32-item survey. Perception of learning was a personal assessment examining the level to which one obtained knowledge (Eom et al., 2006), and satisfaction was the perception of success in the learning experience (Sweeney & Ingram, 2001). The major items on the survey focused on the perception of online learning, perception of face-to-face learning, satisfaction of online learning and satisfaction of face-to-face learning. Each of these four areas had items on the survey that examined the participants' perceptions using a Likert scale with ratings from 1 (*strongly disagree*) to 5 (*strongly agree*). The perception of learning and satisfaction survey was completed using Quizmaker.com.

The data was analyzed for all 32-items using a Pearson Correlation coefficient data analysis tool. The questions were grouped into the four focus areas and a Pearson correlation coefficient was used to analyze this data. Correlations are shown on Table 4 and Table 5.

Table 4

Means and Standard Deviations of Variables on Survey

	M	*SD*
Perception of Online Learning	3.42	.56
Perception of Face-to-face Learning	4.25	.39
Satisfaction of Online Learning	3.59	.60
Satisfaction of Face-to-face Learning	4.27	.40

Note. *N* = 16.

Table 5

Corrleations Between Four Variables on Survey

Measure	1	2	3	4
1. Perception of Online Learning	-	-.41	.61*	-.27
2. Perception of Face-to-face Learning		-	-.58*	-.74**
3. Satisfaction of Online Learning			-	-.55*
4. Satisfaction of Face-to-face Learning				-

Note. *p<.05. **p<.001.

A series of Pearson correlation coefficients were computed to examine relationships among perception and satisfaction for both online and face-to-face learning (see Table 4 and 5). Perception of face-to-face learning and perception of online learning correlation was not significant. This revealed there was no difference between the student perceptions of the learning modalities. Perception of online learning was positively correlated to satisfaction of online learning, $r(14) = .61$, $p = .01$. That is, positive perceptions of online learning were associated with greater satisfaction in online learning. There was a significant negative correlation between perception of face-to-face learning and satisfaction of online learning, $r(14) = -.57$, $p = .02$, with more positive perceptions of face-to-face learning being associated with lower levels of satisfaction with online learning. Similarly, satisfaction with online learning was negatively correlated to satisfaction of face-to-face learning, $r(14) = -.55$, $p = .03$. That is, with increased satisfaction of online learning there is less satisfaction with face-to-face learning. Finally, there was a positive correlation between perception of face-to-face learning and satisfaction of face-to-face learning, $r(14) = .74$, $p = .001$, with more positive perceptions of face-to-face learning being associated with greater satisfaction with face-to-face learning.

From the survey, two items were of specific focus when comparing perception of online learning and perception of satisfaction. These items were "I learned more in the face-to-face labs as compared to the virtual labs" and "I learned more in the virtual labs as compared to the face-to-face labs." Using a Pearson correlation coefficient, these items were compared to the other items on the survey (see Table 6 and Table 7).

Table 6

Correlations of "I learned more in the face-to-face labs as compared to the virtual labs"

Survey Question	Correlation
Virtual labs can replace dissected cadavers in teaching of anatomy (15)	-.50*
Cadavers provide important elements in learning anatomy (17)	.55*
Virtual labs are useful in learning anatomy outside the classroom (19)	-.59*
I learned more in the virtual labs as compared to the face-to-face labs (22)	-.64**

Note. **p*<.05. ***p*<.001.

Using the survey item "I learned more in the face-to-face labs as compared to the virtual labs", a Pearson correlation coefficient was computed to assess the relationship between this survey item and the other items on the survey. The survey items that were significant are presented in Table 6. The survey item "Cadavers provide important elements in learning anatomy" was positively correlated to "I learned more in the face-to-face labs as compared to the virtual labs", $r(14) = .55$, $p = .03$. Positive perceptions in the application of cadavers for learning anatomy were associated with learning more in face-to-face labs. There was a significant negative correlation of "I learned more in the face-to-face labs as compared to the virtual labs" and the following two survey items at the $p = .05$ significance level: "Virtual labs can replace dissected cadavers in teaching of anatomy", $r(14) = -.50$, $p = .05$, and "Virtual labs are useful in learning anatomy outside the classroom," $r(14) = -.59$, $p = .02$. Positive perceptions of learning in face-to-face labs revealed less positive perceptions in using virtual labs to replace cadavers and less positive perceptions of virtual labs being beneficial to learn anatomy when not in a physical classroom. Lastly, the survey item "I learned more in the virtual labs as compared to the face-to-face labs", $r(14) = -.64$, $p = .008$, was also negatively correlated, but at a $p = .001$ significance level when compared to "I learned more in the face-to-face labs as compared to the virtual labs." Positive perceptions of learning in face-to-face labs revealed negative perceptions of learning in virtual labs.

Table 7

Correlations of "I learned more in the virtual labs as compared to the face-to-face labs"

Survey Question	Correlation
I am comfortable with online learning (2)	-.80**
I am comfortable with Anatomy and Physiology Revealed program (3)	.51*
Virtual labs are preferable to studying cadavers (13)	.58*
Virtual labs can replace dissected cadavers in teaching of anatomy (15)	.77**
Virtual labs provide important elements in learning anatomy (16)	.51*
Virtual labs are useful in learning anatomy outside the classroom (19)	.74**
Virtual labs are useful in reviewing anatomy outside the classroom (20)	.63**
I learned more in the face-to-face labs as compared to the virtual labs (21)	-.64**

Note. $*p<.05$. $**p<.001$.

A Pearson correlation coefficient was computed to assess the relationship between the survey item "I learned more in the virtual labs as compared to the face-to-face labs" and the other items on the survey. The significant results are presented on Table 7. There was a significant negative correlation at the $p < .001$ level to the survey items "I am comfortable with online learning", $r(14) = -.80$, $p = .001$, and "I learned more in the face-to-face labs as compared to the virtual labs", $r(14) = -.64$, $p = .008$. Positive perceptions of virtual labs revealed negative perceptions of comfort in online learning and negative perceptions of learning more in a face-to-face lab. The survey item "I learned more in the virtual labs as compared to the face-to-face labs" was positively correlated to the following survey items at a $p < .05$ level: "I am comfortable with Anatomy and Physiology Revealed program", *r*(14) = .51, *p* = .05; "Virtual labs are preferable to studying cadavers", *r*(14) = .58, *p* = .02; and "Virtual labs provide important elements in learning anatomy", *r*(14) = .51, *p* = .04. Positive perceptions of learning in virtual labs revealed positive perceptions of comfort with the virtual lab technology program used in the research, preference for using virtual labs over cadavers, and finding virtual labs to be useful for learning anatomy. Similarly, the following survey items were positively correlated to the survey item "I learned more in the virtual labs as compared to the face-to-face labs", but at a significance level of p <.001: "Virtual labs can replace dissected cadavers in teaching of anatomy", *r*(14) = .77, *p* = .001; "Virtual labs are useful in learning anatomy outside the classroom", *r*(14) = .74, *p* = .001; and "Virtual labs are useful in reviewing anatomy outside the classroom", *r*(14) = .62, *p* = .009. That is, positive perceptions of learning in virtual labs showed positive perceptions of using virtual labs over cadavers to instruct anatomy, using virtual labs outside a classroom to learn anatomy as well as using virtual labs to review anatomy.

In conclusion for research question 2, the data revealed perception of face-to-face learning and perception of online learning was not significant. However, satisfaction of face-to-face learning and satisfaction of online learning was significant. Perception of online learning was significant with satisfaction of online learning, but not with satisfaction of face-to-face learning. Conversely, perception of face-to-face learning was significant to both satisfaction of face-to-face learning and satisfaction of online learning. Overall, those with positive perceptions of face-to-face labs (as measured by the question "I learned more in the face-to-face labs compared to virtual labs) tended to be more positive about the role of cadavers providing important elements for learning anatomy, and had somewhat less positive perceptions of using virtual labs to learn anatomy, replacing dissected cadavers, and learning that took place in virtual labs. Less positive perceptions (as measured by the question "I learned more in the virtual labs compared to the face-to-face labs) were found with the comfort level of online learning and the learning that occurred in face-to-face labs. Perceptions tended to be more positive of virtual labs use in replacing dissected cadavers for studying and learning anatomy as well as using virtual labs for learning outside the classroom and reviewing outside the classroom. There were positive perceptions about the virtual lab program and using virtual labs to replace cadavers.

Summary

Overall, the results for research questions 1 supported significant differences when comparing the pretest learning outcomes to the face-to-face posttests and online posttests learning outcomes. Both posttests revealed significant differences between the modalities of face-to-face cadaver dissection lab and virtual cadaver dissection lab. In survey results for research question 2, there was not a significant difference between perception of face-to-face learning and online learning, however, there were significant findings between satisfaction of face-to-face learning and satisfaction of online learning. The two items of specific focus in perception of learning resulted in positive perceptions and less positive perceptions. Face-to-face cadaver labs were perceived more positive with the application of cadavers for learning anatomy, and virtual labs were perceived more positive with using virtual cadavers for learning and reviewing anatomy. The implications and discussions of the results will be explored in Chapter 5.

CHAPTER V: DISCUSSION AND SUMMARY

This study examined the levels of achievement in learning outcomes in two sections of an anatomy course when comparing face-to-face anatomy dissection labs to online anatomy dissection labs. In addition, the study examined outcomes of a personal assessment survey by the student on perception of learning and satisfaction. This chapter will interpret results, correlate results to literature and theoretical context, discuss implications for education, and future research suggestions.

Summary of Study

In higher education, the traditional method of face-to-face course delivery offerings is facing competition from an increasing amount of online course delivery offerings (Lao & Gonzales, 2005; Rickard, 2010; Wang et al., 2013; Ward et al., 2010). Online learning is preferable to modern students because the choice of when and where to learn is decided by the student (Hart & Morgan, 2010; Kenny, 2002). This current modality of learning is becoming more common with over 28.4% of higher education students enrolled in at least one online course as of 2014 (Allen & Seaman, 2016; U. S. Department of Education, National Center for Education Statistics, 2013). Due to its popularity, it has become a key aspect of strategic growth for higher education institutions (Allen & Seaman, 2016). Higher education institutions are increasingly offering more online courses to meet the demands of current students.

When comparing face-to-face learning and online learning, some studies have revealed there are no significant differences in levels of achievement in learning outcomes (Ma & Nickerson, 2006; Neuhauser, 2002; Olson & Wisher, 2002; Russell, 2001; Sussman & Dutter 2010). Other studies suggest online learning levels of achievement are increased when compared to face-to-face (Koutsabasis et al., 2011; Means et al., 2009; Shachar and Neumann, 2010).

Some studies reveal levels of achievement in face-to-face learning are increased when compared to online learning (Emerson & Mackay, 2011; Garman, 2012; Hughes, 2000 Mottarella et al., 2004; Salterelli et al., 2014). In order to measure levels of achievement in learning of students, learning outcomes are a tool that can be used to compare face-to-face and online learning outcomes.

Science courses are perceived to be difficult to implement into online learning as traditionally there is a face-to-face hands-on lab to accompany the instructed lecture material (Instructional Technology Council, 2013; Rehman, et al., 2012; Wang et al., 2013). With offering online learning for science courses, the face-to-face hands-on lab has to be transformed into an accessible online lab (Corter et al., 2007; Ma & Nickerson, 2006; Mathiowetz et al., 2016; Rehman et al., 2012). For example, traditional higher education offerings of a health science course include a face-to-face lab with models and specimens for manipulation and dissection (Codd & Choudhury, 2011; Yammine & Violato, 2015). However, in offering an online health science lab, the dissection must occur using online technology tools in order to mimic the face-to-face experience (Corter et al., 2007; Ma & Nickerson, 2006). These technology tools include, but are not limited to, interactive computer programs, virtual labs, and at-home kits (Corter et al., 2007; Ma & Nickerson, 2006; Mathiowetz et al., 2016; Rehman et al., 2012). Face-to-face science lab objectives can now be accomplished using online tools, and this enables online science labs to be offered.

This research study used two sections of a fall offering of a health science anatomy course from a private Midwestern university. The two sections were a convenience sample with 71 possible students. A total of 24 students participated in the research with eight in one group and 16 in the other group. Two types of data collection tools were used in the research:

classroom room exams (three) and a survey. One pretest and two posttest exams were used to measure levels of achievement in learning outcomes in a face-to-face anatomy dissection lab and an online anatomy dissection lab. The pretest had questions that covered both topics being instructed, which were blood vessels identification and nervous system structures. The posttest exams each covered one of the topics after instruction on that specific topic. When in the face-to-face anatomy dissection lab, the exam was given in a face-to-face format, and when in the online anatomy dissection lab, the exam was given in an online format. The second tool was a personal assessment survey by the student on perception of learning and satisfaction in which students assessed themselves based upon thirty-three outcome statements using a Likert scale.

The design of the study was a two-group switching replication design. The two treatments were a face-to-face anatomy dissection lab and an online anatomy dissection lab. This design supported the research as this ensured the two groups would be exposed to both treatments. During the instruction of blood vessel identification, one group was the face-to-face anatomy dissection group and one group was the online anatomy dissection group. These groups then switched for the second instruction topic on nervous system structures. That is, the face-to-face anatomy dissection group became the online anatomy dissection group, and the online anatomy dissection group became the face-to-face anatomy dissection group. During each instructed topic, the groups watched the same 20-minute lecture. Then, both groups were allotted the same time to examine and study on either the real cadaver or the online cadaver. At the end of each topic instruction, a posttest was administered which resulted in each student completing a posttest in a face-to-face format and an online format. Following the completion of the treatments, the students completed a personal assessment survey online. The data from all the exams and survey were analyzed using SPSS. The results of the three exams used a one-way between subjects ANOVA with post-hoc tukey to measure levels of achievement in learning outcomes, and a Pearson correlation coefficient was used to analyze data from the perception of learning and satisfaction survey. Two research questions were addressed with these tools.

1. Do levels of achievement in learning outcomes differ on examinations for undergraduate health science students when using a face-to-face dissection lab compared to an online dissection lab at a private Midwestern university?
2. What are undergraduate health science students' rated perceptions of learning and satisfaction of online anatomy dissection labs at a private Midwestern university?

These research questions address the concern about the levels of achievement in learning outcomes in online anatomy dissection labs and furthers the understanding in perceptions of learning and satisfaction in health science students.

Research Questions and Interpretation

Online cadaver dissection labs are increasingly being used in place of real cadaver dissection labs. There is limited research about how these technologies and multimedia compare to learning on real cadavers (Corter et al., 2007; C. R. Davis et al., 2014; Mathiowetz et al., 2016; Saltarelli et al., 2014). This research added to the literature through a two-group switching replication study comparing learning outcomes from a face-to-face anatomy dissection lab and from an online anatomy dissection lab. In addition, the research examined perceptions of learning and satisfaction of anatomy dissection labs.

Research Question 1

Do levels of achievement in learning outcomes differ on examinations for undergraduate health science students when using a face-to-face dissection lab compared to an online dissection lab at a private Midwestern university?

Findings. A one-way between subjects ANOVA with post-hoc Tukey was used on the learning outcome scores of the three exams: one pretest exam and two posttest exams. Learning outcomes were used in this research study as they can be examined through replication of material by continually examining the same phenomenon with different methods (Sussman & Dutter, 2010). The learning outcomes were established as the desired results which is step one in UbD, and then the instruction and assessments were based off the learning outcomes (Wiggins & McTighe, 2005). Constructivism is evident in stage one as the approach for developing learning outcomes is student-centered (Huang, 2002; Wiggins & McTighe, 2005). The pretest included learning outcome items pertaining to both blood vessels identification and nervous system structures identification, and this was completed during week one of the research study. All participants completed the pretest to set a foundation to compare learning outcome results from pretest to posttest. The pretest was compared individually to the posttest blood vessels identification learning outcomes and to the posttest nervous system structures learning outcomes.

Both online and face-to-face assessments revealed significant differences as the posttest learning outcomes increased when compared to pretest learning outcomes. Not surprisingly, this suggested learning occurred in both learning formats, which is supported by Fancovicovoa and Prokop (2014), Lalley et al. (2010), and McKeough, Mattern-Baxter, & Barakatt (2010). The modality of the posttest, whether face-to-face or online, revealed an increase in the learning outcomes. This suggests learning occurred from pretest to posttest, no matter if the exam was taken in a face-to-face format or an online format. This is a significant finding as it suggests students can be successful in exams regardless of the format in which it is completed. Therefore, student learning can occur in an online format.

There is concern that the level of achievement in learning outcomes from online science labs are lacking when compared to face-to-face science labs (C. R. Davis et al., 2014; Ma & Nickerson, 2006; Mathiowetz et al., 2016; Saltarelli et al., 2014). Questions arise about the realism, efficacy, and safety of students in virtual labs who desire to be an employee of the healthcare field (Silen et al., 2008). One such example of concern pertains to the level of achievement in learning outcomes from an online anatomy dissection lab (Mathiowetz et al., 2016; Saltarelli et al., 2014; Stuckey-Mitchell & Stuckey-Danner, 2007). This concern exists because in a face-to-face anatomy dissection lab students have an opportunity to observe and manipulate the structures of the organism in 3D which enables the students to gain familiarity with the texture, touch, and relationship of structures (Codd & Choudhury, 2011). Support for the effectiveness in levels of achievement in learning outcomes when learning in a face-to-face anatomy dissection lab is found in literature (Cross & Cross, 2004; Fancovicova & Prokop, 2014; Ihde, 2011; Mathiowetz et al., 2016; Peat & Taylor, 2004; Saltarelli et al., 2014; Silen et al., 2008). Studies suggest students preferred physical dissection because it permitted them to become familiar with the kinesthetic aspects and orientation of an organism (Ihde, 2011; Silen et al., 2008). Evidence exists to support physical dissection as effective in learning.

In dissimilarity, an online anatomy dissection lab is centered around manipulation of an organism by a computer mouse in addition to prosected images, diagrams, or photographs in a two-dimensional plane (Codd & Choudhury, 2011; Rehman et al., 2012; Saltarelli et al., 2014). Online anatomy dissection support is found in the literature (Codd & Choudhury, 2011; Hughes, 2000; Kinzie et al., 1993; Lalley et al., 2010). Students preferred online anatomy dissection for the convenience and flexibility as well as easy-to-use tools for manipulation (Corter et al., 2004). There exists a paucity in research addressing the levels of achievement in learning outcomes in online anatomy dissection labs focusing on health science students (Mathiowetz et al., 2016; Saltarelli et al., 2014; Stuckey-Mitchell & Stuckey-Danner, 2007). Therefore, examining levels of achievement in learning outcomes in face-to-face anatomy dissection labs when compared to online anatomy dissection labs is warranted.

Data analysis compared the learning outcomes from posttest exams for face-to-face blood vessels identification and online blood vessels identification as well as comparing learning outcomes for face-to-face nervous system structures and online nervous system structures. Each group was instructed in anatomy cadaver dissection in a face-to-face format and an online format. Stage three of UbD, "Plan Learning Experiences and Instruction," is when instructors support the desired levels of achievement in learning outcomes established in stage one and the assessments and performance tasks of stage two by developing authentic instruction and learning (Wiggins & McTighe, 2005). Stage three guided instruction and learning in this research study. There were significant differences in the comparison of face-to-face posttest learning outcomes and online posttest learning outcomes. Interestingly, the overall results did not favor face-to-face learning over online learning or online learning over face-to-face learning. In fact, each instructed topic (blood vessels identification and nervous system structures) revealed a difference in learning outcomes with each instructed topic favoring a different modality of learning. Blood vessels identification posttest learning outcomes revealed face-to-face learners out performed online learners whereas nervous system structures posttest learning outcomes revealed online learners out performed face-to-face learners. These findings suggest that the difference is not in the modality, but perhaps the differences are in the learning styles of students, the topic being instructed, or in the appearance of anatomical structures on a real cadaver compared to an online cadaver.

Learning styles of students can influence their performance in a modality of learning, and examining the preferred learning styles of modern students is important for future offerings of face-to-face labs and online labs (C. R. Davis et al., 2014). Face-to-face anatomy dissection lab favors kinesthetic and haptic learning styles while online cadaver dissection labs favor visual learning styles (Corter et al., 2004). Face-to-face anatomy dissection labs provide a haptic experience that integrates theory of dissection with the practice of dissection, and it can improve manual dexterity (E. O. Johnson et al., 2012; McLachlan, 2004). Online anatomy dissection labs support modern students who appreciate new technology and active methods for learning (C. R. Davis et al., 2014). Since there was no difference favoring one learning style over the other, perhaps the modern students in this research study were adept at learning in a face-to-face format and an online format. This suggests there is a multi-modal learning style of modern students, and this is significant for future course offerings. Perhaps due to modern students growing up in a culture of technology, their learning style enables them to learn successfully in both face-to-face and online formats. This multi-modal learning style is an important consideration in developing and offering higher education courses in various modalities as it seems modern students can learn in either format.

The topic being instructed could have had an influence on learning outcomes. In this research, the topics of blood vessels identification and nervous system structures identification were chosen as the topics. Previous research had also chosen these topics for their research study (McKeough et al., 2010; Lombardi et al., 2014; Saltarelli et al., 2014) while others selected different topics such as muscles (Codd & Choudhury, 2011) and cardiovascular, respiratory, and musculoskeletal (Anderton et al., 2016). At present, there is limited research on the influence of a topic on the learning outcomes of face-to-face anatomy dissection labs and online anatomy dissection labs. Some organs and systems are different in their complexity and spatial arrangement in the body, and therefore, this might influence learning outcomes (Yammine & Violato, 2015). The influence of complexity and spatial arrangement on the topics instructed in an anatomy dissection lab is an important consideration for future instruction. This implies the learning of topics in an anatomy dissection lab may be influenced by the topic being instructed. The influence of topic on learning outcomes involves many other elements to consider such as method of instruction, inherent complexity of the topic, and the learner's preferred learning style. The relationship of topic in anatomy to learning outcomes is an important consideration for future research.

Perhaps the learning outcomes in this research were influenced by the appearance of structures in a real cadaver as compared to an online cadaver. A real cadaver is messy with complex connective tissue, fascia, and fat, and this complexity is not shown in online cadavers as the online anatomy dissection lab makes the body clean and simple (Allchin, 2005; McLachlan, 2004; Silen et al., 2008; Yammine & Violato, 2015). Real cadavers present the spatial information of human bodies in a way that online cadavers cannot emulate, but structures can be hard to find (Codd & Choudhury, 2011; Mathiowetz et al., 2016; Predavec, 2001; Silen et al., 2008). In real cadaver labs, dissection is typically conducted in one day and provides students with kinesthetic and haptic experiences, however, the opportunity for additional studying outside the one day of dissection on the real cadaver is minimal and could limit retention (Lalley et al., 2010; Mathiowetz et al., 2016; Predavec, 2001; Sugand et al., 2010). Although a real cadaver provides experiences an online cadaver cannot, it can be a challenge to identify structures and review structures on the real cadaver outside of the face-to-face anatomy lab.

In an online anatomy dissection lab with an online cadaver, the anatomy dissection lab is user friendly and is rooted in being student-centered and student-controlled, which is an aspect of constructivist theory (Chou & Liu, 2005; Huang, 2002; Predavec, 2001; Silen et al., 2008). An online cadaver has a high degree of interactivity and active participation (Corter et al., 2007; C. R. Davis et al., 2014; E. O. Johnson et al., 2012). An online cadaver enables the students to see all the structures intact, immediately identify if it is the proper structure or not, and students can work at their own pace with the ability to review it as many times as desired (Lalley et al., 2010; Predavec, 2001). An online cadaver allows structures to be zoomed in on, rotated, highlighted, and identified immediately (Rehman et al., 2012). The online anatomy dissection labs enable students to continue to review the online cadaver to the student's discretion without having to be in a physical lab (C. R. Davis et al., 2014; E. O. Johnson et al., 2012). An online cadaver, however, is missing the kinesthetic experience and spatial awareness of a real cadaver (Codd & Choudhury, 2011; Lalley et al., 2010; Mathiowetz et al., 2016; Predavec, 2001; Sugand et al., 2010). An online cadaver is beneficial for a cleaner look at the anatomy of a human as well as the accessibility to review outside of an anatomy lab. This appeals to the convenience and flexibility demands of modern students.

Given this aforementioned information about the differences between a real cadaver and an online cadaver, it is worth discussing the potential effects these differences may have had on the levels of achievement in learning outcomes in this research study. Perhaps blood vessels in a real cadaver were seen more clearly than in an online cadaver which resulted in the face-to-face group outperforming the online group on this particular topic in this research study. In contrast, perhaps nervous system structures were seen more clearly in an online cadaver than in a real cadaver which resulted in the online group outperforming the face-to-face group on this specific topic in this research study. A real cadaver may not provide adequate information pertaining to neurology and neuroanatomy, and students may find it challenging to identify structures and recognize the 3D relationship (McKeough et al., 2010; Rehman et al., 2012). Therefore, nervous system structures may be best studied and learned in an online cadaver while blood vessels identification may be best studied in a real cadaver. This suggests there is a need for both real cadavers and online cadavers, and this supports a multi-modal approach to learning anatomy. A multi-modal approach to learning anatomy appeals to many different learning styles and supports success in learning anatomy no matter one's learning style.

There are important considerations when institutions are weighing the financial costs of supporting a real cadaver lab as this research study implies there is a difference in learning on a real cadaver and an online cadaver. The financial costs of maintaining a real cadaver lab seems to be one of the most highly considered reason to remove real cadavers and put in place virtual cadavers (Allchin, 2005; Codd & Choudhury, 2011; Hughes, 2000; Mathiowetz et al., 2016; Mayfield et al., 2013; McLachlan, 2004; Peat & Taylor, 2004; Rehman et al., 2012; Saltarelli et al., 2014). Through this research study, it seems some topics in anatomy may be better seen in a real cadaver or in an online cadaver. Therefore, a multi-modal approach to learning anatomy would ensure all topics in anatomy could be thoroughly learned with using both a real cadaver and an online cadaver.

The findings in this research are both supported and contradicted by previous research examining face-to-face anatomy dissection labs and online learning anatomy dissection labs. Research supporting increased levels of achievement in learning outcomes in face-to-face anatomy dissection over online anatomy dissection learning outcomes are found in Cross and Cross (2004), Fancovicova and Prokop (2014), Mathiowetz et al. (2016), and Saltarelli et al.

(2014). Research supporting increased levels of achievement in learning outcomes in online anatomy dissection learning outcomes over face-to-face anatomy dissection learning outcomes are revealed in Codd and Choudhury (2011), Hughes (2000), Lalley et al. (2010), and Predavec (2001). The findings in this research study reveals there is value in both modalities of face-to-face anatomy dissection lab and online anatomy dissection lab. This indicates a multi-modal approach is beneficial. The application of multi-modal tools for learning and instruction for learning anatomy is supported in previous research from Biasutto et al. (2005), C. R. Davis et al. (2014), and Peat and Taylor (2004). Based upon the results in this research study, the modality of learning did not seem to be the factor to affect learning outcomes. The findings from this research study support a multi-modal approach to learning anatomy as there was not one modality of learning that produced an increase in learning outcomes.

It is interesting to note that one group did outperform the other group regardless of modality and regardless of topic. As aforementioned one group were participants from the researcher's section of human anatomy and one group were participants from the other section of human anatomy not instructed by the researcher. The face-to-face blood vessels group participants were the same as the online nervous system structures group participants, and the online blood vessels group participants were the same as face-to-face nervous system structures group participants. Between these two groups, one of the groups performed higher on both posttests. This group was the face-to-face blood vessels group participants that were the same as the online nervous system structures group participants, and these were the students of the researcher's human anatomy section. It appears this group was better prepared for the posttest exams, and therefore, outperformed the other group who were students of the other section not instructed by the researcher. Perhaps this is due to a difference in work ethic, learning styles, and/or self-motivation between the two groups. In addition, it is feasible that the participants were more comfortable with their instructor's, who was the researcher, voice in instructing the dissection lab or method in instructing the lab, and this had a difference on learning outcomes. The more an instructor emphasizes their method of instruction, the more the student buys into it, and it seems the student's of the non-researchers section were unfamiliar with the method of instruction by the researcher. This demonstrates there may be a connection in results of learning outcomes between instructor and student. It warrants mentioning the participants that came out of the researcher's instructed course section were in the group that scored higher on both posttest exams. The participants that came out of the course that was not instructed by the researcher performed lower on both exams.

Final conclusion of research question one. Results revealed face-to-face anatomy dissection lab on blood vessels identification outperformed online anatomy dissection lab, and online anatomy dissection lab on nervous system structure identification outperformed face-to-face anatomy dissection lab. This currently means there was not one modality of learning that outperformed the other modality which leads to the potential causes for differences in learning outcomes to be due to learning styles, topics instructed, and/or the appearance of topics in a real cadaver as compared to an online cadaver. This is an important finding as it implies modern students can learning in face-to-face and online modalities. The research results for question one imply both modalities of learning are successful, and therefore, future course offerings of anatomy may be successful with a multi-modal approach to learning.

Research Question 2

What are undergraduate health science students' rated perceptions of learning and satisfaction of online anatomy dissection labs at a private Midwestern university?

Findings. A Pearson correlation coefficient was used to examine the relationships among the 32-item survey results. The questions were grouped into four categories of survey questions: perception of online learning, perception of face-to-face learning, satisfaction of online learning, and satisfaction of face-to-face learning. These four categories of questions were analyzed using a Pearson correlation coefficient to test for significance. Then, individual questions were analyzed for significance. The data analysis of the survey generated a large amount of statistical information, and therefore, only results that pertained to this research question will be discussed here. Although levels of achievement in learning outcome scores have been used as a tool to measure learning, these outcome scores are limited in providing a true in-depth understanding (Centra & Gaubatz, 2005). Therefore, an increase in understanding can be achieved through a personal assessment survey by the student on perception of learning and satisfaction. These two data gathering tools of perception of learning and satisfaction are widely used and cited to enhance understanding of efficacy of online learning (Eom et al., 2006; Graham & Scarborough, 2001). The topic of learning and satisfaction has been well-researched, but not in health science students, and here exists a paucity in research.

Results revealed perception of each modality equated to a significant positive correlation with satisfaction in that modality. That is, there was positive perception of online learning which correlated with positive satisfaction of online learning, and there was positive perception of face-to-face learning which correlated with positive satisfaction of face-to-face learning. These findings were significant. In addition, it was not surprising that when there were positive perceptions of one modality, there were lower levels of satisfaction of the other modality. More positive perceptions of face-to-face learning revealed lower levels of satisfaction of online learning, and more positive perceptions of online learning revealed lower levels of satisfaction in face-to-face learning. Collectively, this indicates there is a diverging perception of learning and satisfaction with these two modalities of instruction. This is supported by previous research from Haigh (2007), Palmer and Holt (2009), and Shin and Chan (2004). There is also research to contradict this finding from Chen and Chuang (2012), Iverson et al. (2005), Kelly et al. (2009), Leners et al. (2007), and Mathiowetz et al. (2016) who found there was no significant difference in learning in one modality and satisfaction with the other modality. The results from this study imply students are satisfied with each modality of learning, and there is not a preference for one modality of learning over the other modality of learning. Students will have increased perception of learning and satisfaction when learning in either of the modalities. This supports a multi-modal approach to learning anatomy as no matter the modality for learning, students will have increased perceptions of learning and satisfaction. Therefore, students can learn and be satisfied in either, or, and both face-to-face learning and online learning.

Based on the research data, there were two focus items on the survey as the two items specifically compared the perception of learning in face-to-face labs and perception of learning in online labs. A Pearson correlation coefficient was computed to assess the relationship from these two focus items to the other survey items. The two items were "I learned more in the face-to-face lab as compared to the virtual labs" and "I learned more in the virtual labs as compared to the face-to-face labs". When these two items were correlated, it revealed a negative correlation. An increase in perception of face-to-face learning revealed a decrease in perception of online learning, and an increase in perception of online learning resulted in a decrease in perception of face-to-face learning. This finding supports the previous finding in which there is diverging perceptions of face-to-face and online learning. This finding implies there is a relationship of learning styles of students and their perception of learning. Students that are more kinesthetic would rate online courses lower for ease of use, feeling immersed, and convenience of scheduling, while those with visual style and read/write cognitive style would feel the exact opposite (Corter et al., 2004). Future research on the relationship between student learning styles and perceptions of learning is imperative for deepening the understanding online learning. Since online learning is an integral part of higher education course offerings and will continue to be integral, there needs to be a focus on learning styles influence to perception of learning and learning outcomes. Understanding the effect of learning styles is a critical aspect for developing and implementing quality online courses in which students learn as well as faculty knowledge when designing courses. Knowing one's learning style is also a factor in selecting a modality of a course as this could influence the students' learning outcomes and perception of learning.

The first focus item "I learned more in the face-to-face lab as compared to the virtual labs" revealed positive correlation to the survey item "Cadavers provide important elements in learning anatomy". This suggests cadavers are valuable learning tools to learn anatomy in a face-to-face dissection lab. While some studies have produced varying results of the use of cadavers in learning anatomy, there is previous research corroborating evidence in which students place a high value on cadavers to learn and understand anatomy (Anderton et al., 2016; C. R. Davis et al., 2014; Mathiowetz et al., 2016; Rehman et al., 2012). For example, C. R. Davis et al. (2014) research that found over 95% of surveyed participants agreed that cadavers are an important learning tool for understanding anatomy. Students still prefer cadavers over e-learning technologies (C. R. Davis et al., 2014). The students in the current study found value in the use of cadavers to learn anatomy. Visuospatial abilities developed when studying a real human specimen are crucial to developing health care providers and especially, for surgical skills (Haluck & Krummel, 2000). Evidence from this research study suggests there is still a need for cadavers to learn anatomy which indicates a multi-modal approach to learning anatomy is needed. The results imply cadavers are valuable for learning and are still needed to learn anatomy upon. This is an important consideration when institutions are looking at the financial aspect of upholding a real cadaver lab. The results from this research study support there is still a need for real cadavers to learn anatomy.

There were survey items that revealed a negative correlation to “I learned more in the face-to-face lab as compared to the virtual labs”. Collectively, these items pertained to the use online labs in learning anatomy. This means with more positive perceptions of face-to-face anatomy dissection labs there were less positive perceptions of the use of online anatomy dissection labs. Specifically, the significant items pertained to using online cadavers to replace real cadavers, using virtual labs to learn anatomy outside the classroom, and learning more in virtual labs compared to face-to-face labs. The suggests, as aforementioned, the students perceived there is a need for cadavers in learning anatomy and online labs cannot replace cadavers. Previous research from Anderton et al. (2016), C. R. Davis et al. (2014), Mathiowetz et al. (2016), and Rehman et al. (2012) supports these findings. However, there is research that contradicts this finding in that virtual labs can replace cadavers or are evaluated to have the same usefulness as virtual labs. For example, Corter et al.(2004) found 10% of respondents believed online labs were “more effective” than face-to-face, however, 72% perceived the labs to be about the same. Other research found technology to be realistic enough to mimic the face-to-face experience, and therefore, the virtual labs can feel as authentic as face-to-face labs (Sauter et al., 2013). Perhaps, the results from these previous research studies implies not that real cadavers can truly be replaced, but there is a value in the application of online cadavers for learning anatomy. Online cadavers can feel like the “real thing”, but they are not and evidence from this research suggests students recognize the worth in both real cadavers and online cadavers. This suggests both play a critical role in learning anatomy.

The second focus survey item was "I learned more in the virtual labs as compared to the face-to-face labs." Collectively, the survey results revealed positive correlations related to the use of online labs for learning anatomy and negative correlations related to using face-to-face labs for learning anatomy. Not surprisingly, online labs were positively correlated to comfort with using the computer online lab program and using online labs to study online cadavers. Online labs provide the convenience and flexibility of online learning and meet the demands of modern students (C. R. Davis, 2014; Nedic et al., 2003; Peat & Taylor, 2004). In addition, modern technology is realistic enough to mimic the face-to-face experience and create an authentic experience for students (Sauter et al., 2013). This suggests the online anatomy dissection labs and online cadavers are sufficient to learn, study, and review human anatomy. This supports the notion of a multi-modal approach to learning anatomy as students can benefit from the application of online anatomy labs and online cadavers.

This research study also revealed positive perceptions of online labs which suggested online cadavers could be used to replace real cadavers. This contradicts previously mentioned findings in which this research study revealed students found value in the use of real cadavers to understand and learn anatomy. Perhaps these findings imply there is a need for both face-to-face anatomy dissection labs with real cadavers and online anatomy dissection labs with online cadavers to learn anatomy, which indicates a multi-modal approach to learning. This is supported in research by Rehman et al. (2012), which found that although students preferred cadavers to study anatomy, they found the virtual cadaver to be useful to learn, study, and review anatomy as well. This does not minimize the need for cadavers to learn, but instead, supplements their use with additional purpose for learning.

Negative correlations to "I learned more in the virtual labs as compared to the face-to-face labs" revealed a surprising correlation. Results showed more positive perceptions of online labs had less positive perceptions of comfort with online learning. This result is surprising as other findings in the research revealed there was comfort with an online lab program and use of the online lab. Perhaps students felt comfort with using the operations of the online lab program, but as whole felt less comfort with online learning. This suggests there still is apprehension to online learning and face-to-face learning is still needed, implying a multi-modal approach to learning anatomy is needed.

Final conclusion of research question 2. When perception of learning and satisfaction of one modality increased, perception and satisfaction for the other modality decreased. This indicates diverging perceptions of the two modalities. Based upon results from this research study, there is still a need for real cadavers to understand and learn anatomy, but there is also a place for online cadavers in understanding and learning anatomy. Students perceptions indicated both play a pivotal role in learning anatomy as both have beneficial aspects for learning. Face-to-face cadaver labs enable touching and manipulating while online cadaver labs enable convenience and flexibility for learning. The multi-modal approach to the use and application of both real cadavers and online cadavers are beneficial for perception of learning and satisfaction in learning anatomy.

Implications for Education

With current data suggesting almost a quarter of all students in higher education are taking at least one online course, continuing research of face-to-face and online learning is important. Online learning is a part of the strategic growth for many institutions. This study supports the notion that the levels of achievement in learning outcomes are not influenced by the modality of instruction.

Replacing Cadaver Labs

Many institutions are using some alternative form of an anatomy dissection lab for online learning and forgoing a face-to-face anatomy dissection lab mainly due to the cost of maintaining a cadaver lab. Understandably, this is one of the reasons for the replacement of face-to-face anatomy dissection labs with online anatomy dissection labs. This research study revealed there was not a modality that was favored to produce increased levels of achievement in learning outcomes, and therefore, it found face-to-face anatomy dissection labs and online anatomy dissection labs to produce similar results in levels of achievement in learning outcomes.

Implication for education would include more research on the efficacy of online anatomy dissection labs. Higher education leadership need to be presented with more information such as research on health science programs, data from comparing the options of virtual cadavers, and learning outcomes from virtual cadavers. Armed with this information, institutions can make sound decisions regarding the replacement of more expensive face-to-face anatomy dissection labs with online anatomy dissection labs.

Student Input

Even though it may be cost effective for institutions to replace face-to-face labs with online labs, examining perceptions of learning and satisfaction in students is an important consideration. Many prior research studies as well as this research study reveal there is still a preference for learning in a face-to-face anatomy dissection on cadavers.

Implications for education would be to survey students' preference and base decisions off student input. Students may still desire cadavers to learn, or online cadavers, or perhaps both. More research needs to be performed on this topic.

Limitations of this Study

In fully examining this research study's results, the limitations of the study must be established and explained. The limitations of this study included sampling, nature of the course, student mortality, and timeline.

Sampling

The sampling was a convenience sample utilizing two sections of an anatomy course. The researcher attempted to account for differences in participants in the two sections of the anatomy course by asking for participants. Originally, the researcher was the instructor for both sections, but this changed based upon the institution's needs and therefore, it could have had limitations on the research outcomes. The researcher had 18 participants out of 23 possible in the section in which the researcher was the instructor, and eight participants out of 48 possible in the section in which the research was not the instructor. It is possible that since the section in which the researcher was the instructor, the participants were more willing to participate in the research as they had been a student of the researcher and felt more comfortable. Therefore, it is possible the low participation from the section not instructed by the researcher could be due to the lack of comfort with the researcher since the participants had not had the researcher as the instructor. Instructors can present a strong method of instructing, and the stronger the method is, the more students will take to the method of instruction. It seems the students in the researcher's section took to the method of instruction better than the students of the non-researcher's section.

In this study, it was not possible to set up equal groups. Due to the convenience sampling and the low numbers of participants, this research may not be generalizable.

Nature of the Course

This study is applicable to students who are pursuing a health profession career and are thereby identified as health science students. The results of the study may be applicable to students outside this discipline. However, the results may not be applicable to courses that do not include a lab component. Due to the research specifically examining the lab component, courses that do not have an accompanying lab may not be applicable.

Student Mortality

The research occurred over seven weeks which fell near the last half of the fall 2016 semester. Although the length and the time commitment were not minimal, there were 5 students that did not complete the entire research study. Two withdrew for time commitments, one was eliminated because the student had taken anatomy before, and two failed to attend the research sessions after initially volunteering.

Sixteen of 26 participants completed the perception of learning and satisfaction survey. All the face-to-face participants (eight) that were in the nervous system structures face-to-face group completed the survey. The online participants in the nervous system structures online group completed the posttest online, and they were then instructed to complete the online survey. Based on the number, it is clear some of the participants did not complete the survey. This research study did not track the individuals who had completed the survey, and therefore, could not determine specifically who did not complete it.

Timeline

The research began immediately upon IRB research. This forced the research to occur in the last half of the fall semester. With a seven-week schedule, the research schedule was influenced by Thanksgiving break. One section had to have two break weeks which then put the research to occur over Thanksgiving break. This potentially could have influenced outcomes of research.

The online anatomy lab lecture and dissection was a challenge to get students to complete. The online participants were given written and verbal directions on how to complete the online anatomy lab dissection and online posttest as well as what dates in which to complete these items. The researcher reminded the online students numerous times and received many verbal and emailed questions over how to access the online lab and how to complete the online posttest even though there was a demonstration as well as written and verbal directions. The questions fielded were not about content but about how access the online anatomy lecture and lab. Face-to-face students did not have these issues. Perhaps with online courses, there is less accountability and perhaps less comfort in knowing how to access online tools and complete tasks.

A further limitation in this research is that it only included one semester and two sections of a human anatomy course. This limited the number of potential participants and results in data to analyze. The research would have been strengthened by having more than one semester of participants and data.

Future Research

Research studies comparing face-to-face anatomy dissection labs and online anatomy dissection labs are lacking (Mathiowetz et al., 2016; Saltarelli et al., 2014; Stuckey-Mitchell &

Stuckey-Danner, 2007). This is most likely due to the relatively new modality of online learning as well as science being a challenging topic to implement online (Instructional Technology Council, 2013; Rehman et al., 2012; Wang et al., 2013). Perception of learning and satisfaction has supportive research in some disciplines, but has limited amounts of research in science courses. Major areas that would warrant future research related to this study include: comparing online and face-to-face, data size, compare different online labs, and compare using different topics.

Comparing Online and Face-to-face

Due to the lack of depth in research comparing face-to-face and online levels of achievements in learning outcomes, there is a great need for this research in all higher education disciplines. Many institutions offer online courses that are intended to mirror their face-to-face format course offering. However, there is limited research that supports the level of achievement in learning outcomes is equivalent when comparing face-to-face learning and online learning. This research could be especially important due to most institutions having online learning as part of their future strategic plan (Allen & Seaman, 2016). Perhaps additional research examining and comparing face-to-face and online learning outcomes would create a clearer understanding of levels of achievement in learning outcomes between these two modalities.

In addition, as evident by the extremely limited amount of research comparing online and face-to-face anatomy dissection labs, it is imperative to have research in this area. Many institutions have difficulty maintaining a cadaver lab due to cost, and there is a need to have research evidence to support that levels of achievement in learning outcomes are not compromised by implementing an online lab in lieu of a face-to-face lab. Additional research is warranted in this area.

Data Size

This research study was based on a single semester data collection, and perhaps if the data set was larger it may have affected the outcome of the study. In order to achieve this, the researcher would most likely need to extend the research collection beyond a single semester and complete data collection over multiple semesters. Future research could increase the length of research from a single semester. It could also be beneficial to select multiple similar in size institutions to complete the research to increase the size of the data. This could provide additional points of analysis for comparing face-to-face anatomy dissection labs and online anatomy dissection labs.

Online Lab Options

This research study utilized an online lab called *Anatomy and Physiology Revealed*, which is produced by a textbook publishing company, McGraw-Hill. This online lab product permits students to manipulate the online cadaver in order to look at many different dimensions and structures in the cadaver. An area of possible future research would be to compare different online anatomy labs in what they offer for manipulation, angles to look at structures, ease and efficacy of learning. These differences could reveal an impact on learning by using certain online anatomy labs. This research could also contribute to providing information to the producers of these online anatomy labs as to what is valuable and what is not beneficial to learning in online anatomy labs.

This research study utilized recorded videos to instruct anatomy dissection labs. An area of future research could be to examine the number of times videos have been viewed by participants to see if there is a correlation to levels of achievement in learning outcomes.

Instruction Topic

The instructed anatomy dissection topics in this research were blood vessel identification and nervous system structures. These topics were chosen because they could adequately be presented in the 20-minute lecture as well as the structures associated with the topic were manageable to manipulate and locate for first time cadaver using participants in this research study. Future research could compare the various topics studied in cadaver based courses to examine if there is a difference in learning outcomes, such as there was in this research, that potentially could influence levels of achievement in learning outcomes. Understanding the anatomy dissection topics that achieve high levels of learning outcomes could benefit future offerings of online anatomy labs as well as give insight to the topics that result in low levels of learning outcomes. The topics with low levels of learning outcomes could be studied to deepen understanding as to why they led to lower levels, and therefore, changes could be made to instruction and online anatomy labs to improve the learning outcome levels.

Summary

This research study examined the levels of achievement in learning outcomes comparing two modalities of learning: face-to-face and online. There has been a large growth in online course offerings as this meets the demands of modern students which is convenience and flexibility. The current research comparing learning outcomes of face-to-face and online are mixed. Some suggest face-to-face learning has higher learning outcomes, while others suggest online learning results in higher learning outcomes, and some studies reveal there is no difference in learning outcomes between the two modalities. In addition, there is limited research available on health science students' perception of learning and satisfaction in online learning. Current research reveals diverging perspectives of online learning. That is, some studies suggest there is greater learning and satisfaction in online learning, while others suggest there is still a need for face-to-face learning.

Participants in this study were health sciences students from a private Midwestern university that were enrolled in anatomy class. Two assessment tools were used in this study. There were three exams and a personal assessment survey. Data analysis examined the learning outcomes of the three exams. There were significant differences between the learning outcomes of the exams, but the results did not reveal an increase in learning outcomes in one type of modality. That is, both types of modalities resulted in an increase in learning outcomes depending upon the topic being instructed which was blood vessels and nervous system structures. Based upon these results, it seems a multi-modal learning style to learning anatomy may be successful. The students in this research study appeared to be able to learn in both modalities, implying the modality is not the reason for significant differences in the levels of achievements in learning outcomes when examining face-to-face learning and online learning.

The outcomes from the survey based upon perception of learning and satisfaction in online learning also revealed significant differences. The results suggest students can learn and are satisfied with both face-to-face learning and online learning. There was not a preference for one type of modality over the other. These results indicate modern students find value in both face-to-face learning and online learning. This is of importance as institutions may replace face-to-face anatomy dissection labs with online anatomy dissection labs due to the financial cost to the institution. These results suggest students desire a multi-modal learning style for learning anatomy.

The research study adds to the current body of research examining levels of achievements in learning outcomes in face-to-face learning and online learning. Future research studies on anatomy dissection labs examining online and face-to-face, online lab options, and effects of instructional topics on learning outcomes should be done to ensure there is no difference in levels of achievements in learning outcomes in face-to-face anatomy dissection labs and online anatomy dissection labs.

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Appendix A

Pretest

Name:____ Score______/15

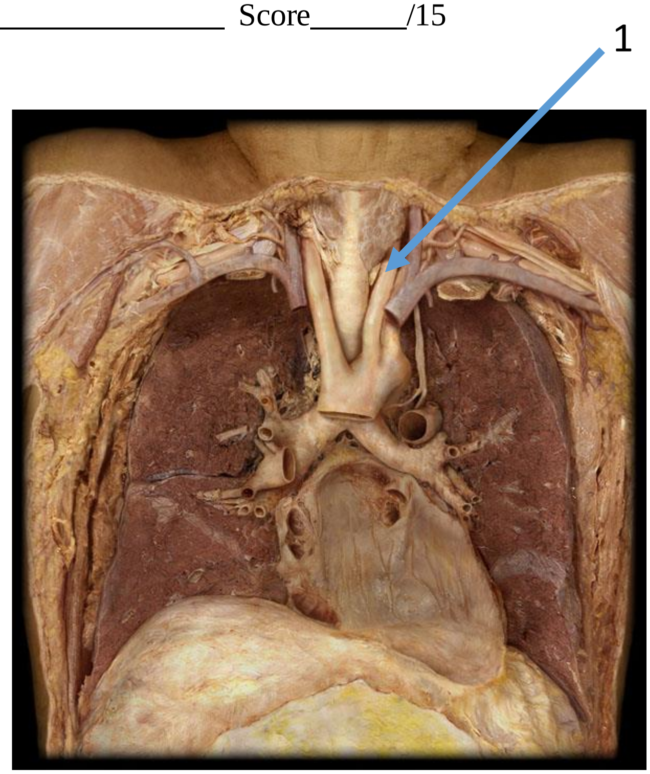
_____ 1. Identify the blood vessel indicated "1":

A. Left common carotid artery

B. Right common carotid artery

C. Right subclavian artery

D. Left subclavian artery



_____ 2. Name the structure the blood vessel "1" indicated flows into:

A. Kidney

B. Brain

C. Stomach

D. Liver

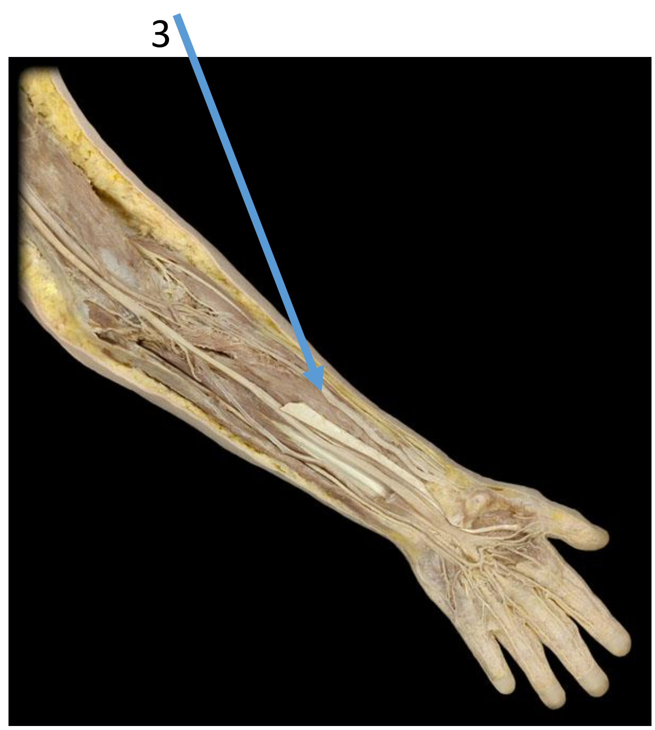
_____ 3. Identify the blood vessel indicated "3":

A. Radial artery

B. Ulnar artery

C. Femoral artery

D. Tibial artery

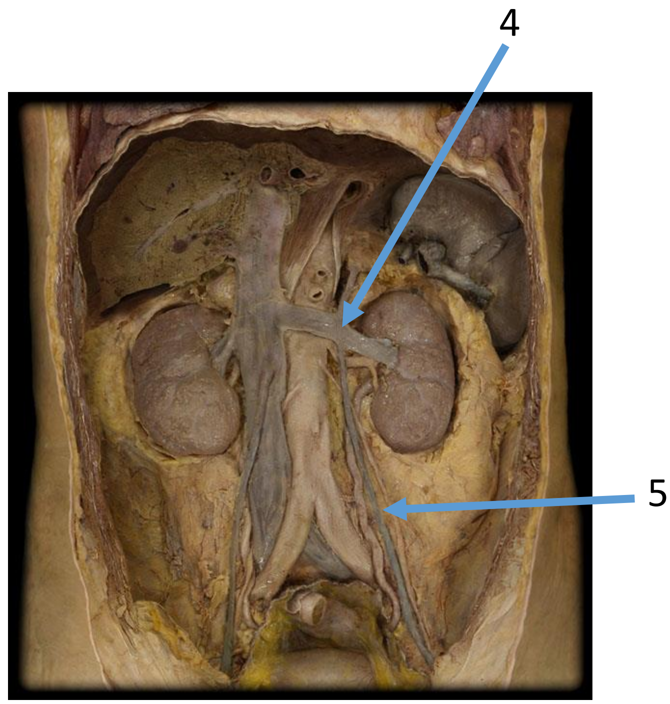


_____ 4. Name the organ the blood vessel indicated supplies "4":

A. Ovary
B. Lungs
C. Kidney
D. Spleen

_____ 5. Identify the blood vessel indicated "5":

A. Great saphenous vein
B. Axillary vein
C. Renal vein
D. Left gonadal

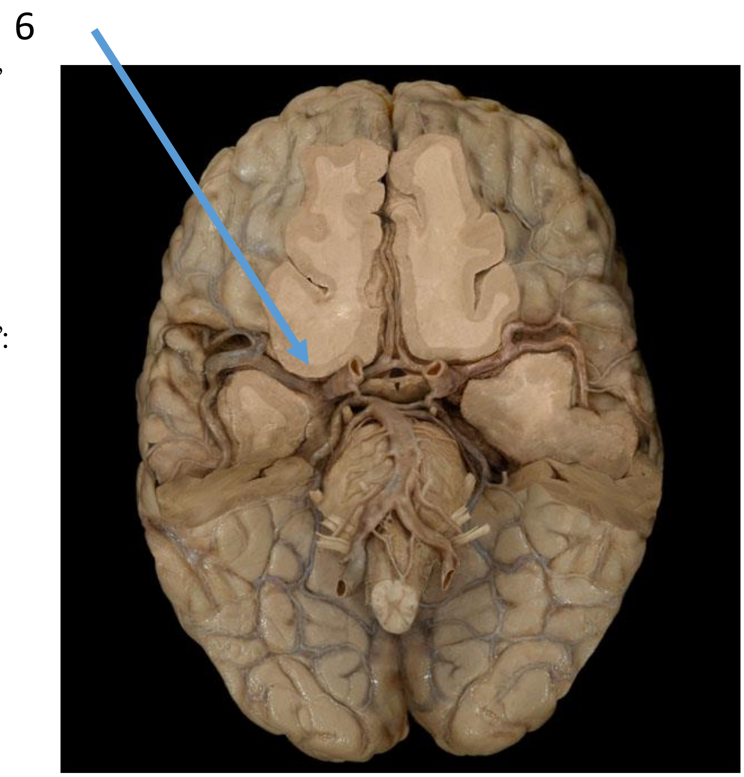


____ 6. Name the structure the blood vessel "6" dedicated flows into

A. Heart
B. Kidney
C. Ovary
D. Brain

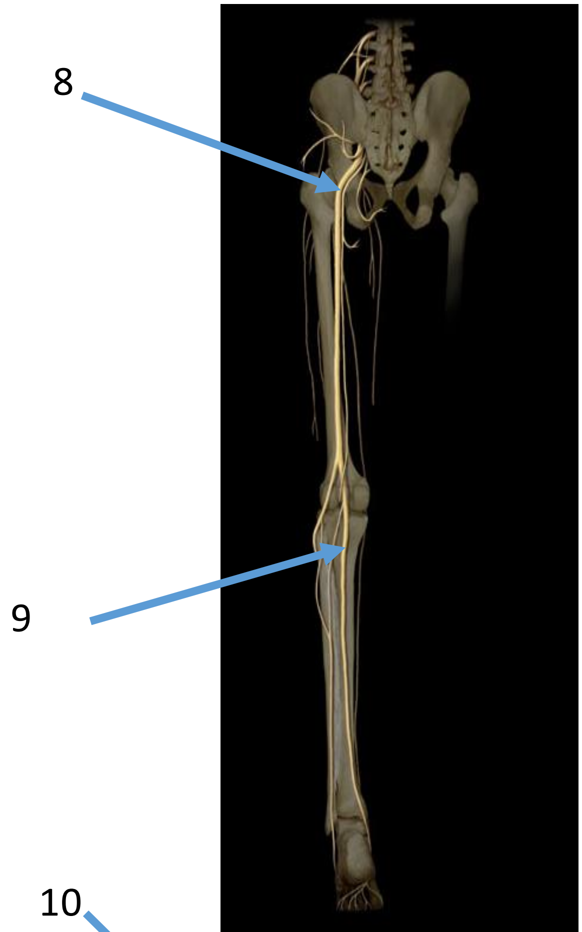
_____ 7. Identify the blood vessel indicated "6":

A. Anterior cerebral artery
B. Posterior cerebral artery
C. Basilar artery
D. Middle cerebral artery



______ 8. Identify the neuron indicated “8”:
A. Sciatic nerve
B. Femoral nerve
C. Posterior tibial nerve
D. Medial plantar nerve

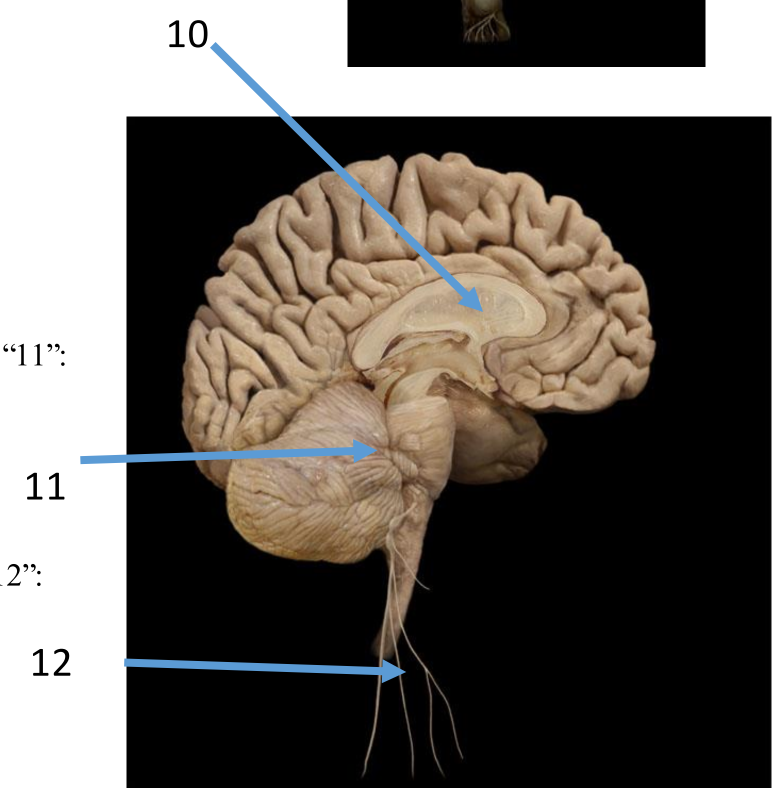
______ 9. Identify the neuron indicated “9”:
A. Posterior tibial nerve
B. Femoral nerve
C. Axillary nerve
D. Vagus nerve



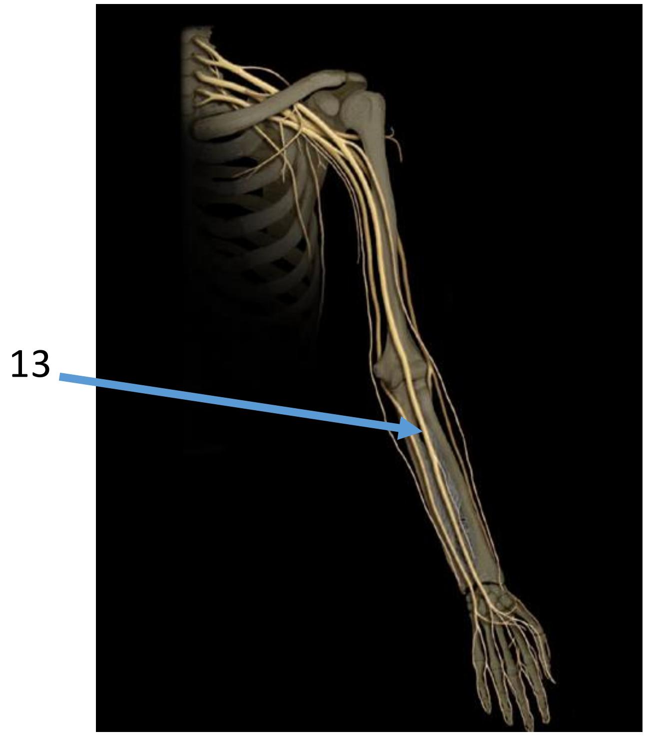
______ 10. Name the space indicated “10”:
A. Lateral ventricle
B. 3rd ventricle
C. 4th ventricle
D. Central canal

______ 11. Identify the structure indicated “11”:
A. Hypothalamus
B. Thalamus
C. Cerebellum
D. Medulla oblongata

______ 12. Identify the neuron indicated “12”:
A. Vagus nerve
B. Phrenic nerve
C. Accessory nerve
D. Hypoglossal nerve

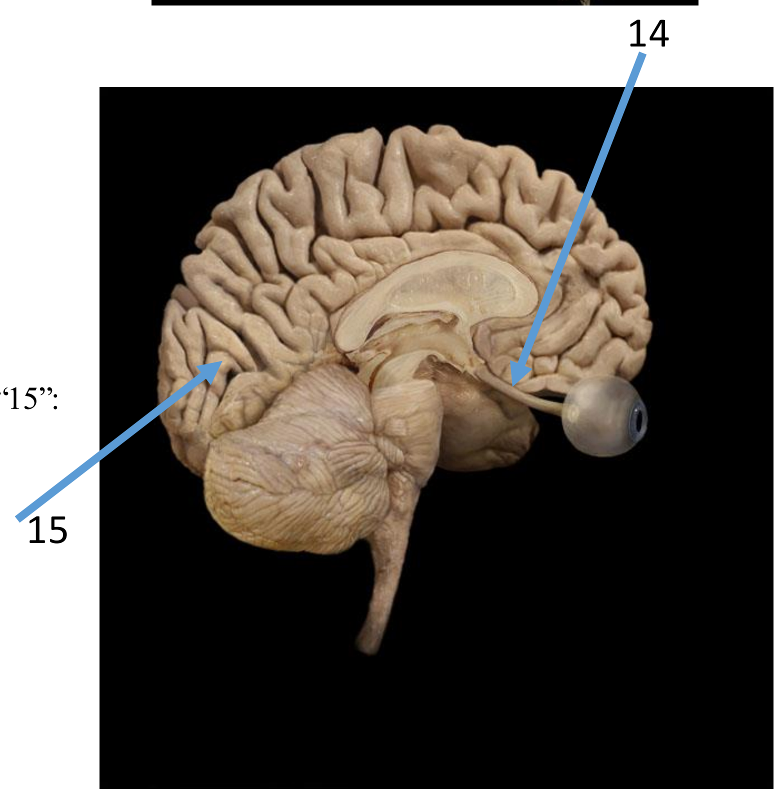


______ 13. Identify the neuron indicated “13”:
A. Radial nerve
B. Musculocutaneous nerve
C. Ulnar nerve
D. Median nerve



______ 14. Name the organ the structure
Indicated “14” supplies:
A. Diaphragm
B. Tongue
C. Muscles of the arm
D. Eye

______ 15. Identify the structure indicated “15”:
A. Midbrain
B. Medulla oblongata
C. Pons
D. Cerebrum



Appendix B

1. Name the structure the blood vessel indicated flows into.
A. Kidney
B. Ovary
C. Brain
D. Heart

2. Identify the blood vessel indicated.
A. Anterior cerebral artery
B. Internal carotid artery
C. Posterior cerebral artery
D. Basilar

3. Identify the blood vessel indicated.
A. Left brachiocephalic vein
B. Brachiocephalic trunk
C. Right brachiocephalic vein
D. Superior vena cava

4. Identify the blood vessel indicated.
A. Right subclavian artery
B. Brachiocephalic trunk
C. Arch of aorta
D. Abdominal aorta

5. Identify the blood vessel indicated.
A. Left common carotid artery
B. Right common carotid artery
C. Right subclavian artery
D. Left subclavian artery

6. Identify the blood vessel indicated.
A. Ulnar artery
B. Femoral artery
C. Tibial artery
D. Radial artery

7. Identify the blood vessel indicated.
A. Brachial artery
B. Axillary artery
C. Subclavian artery
D. Radial artery

8. Identify the blood vessel indicated.
A. Gonadal artery

B. Renal artery
C. Inferior mesenteric artery
D. Superior mesenteric artery

9. Name the structure the blood vessel indicated flows into.
A. Brain
B. Kidney
C. Stomach
D. Liver

10. Identify the blood vessel indicated.
A. Celiac trunk
B. Superior mesenteric artery
C. Inferior mesenteric artery
D. Gonadal artery

11. Identify the blood vessel indicated.
A. Thoracic aorta
B. Arch of aorta
C. Superior mesenteric artery
D. Abdominal aorta

12. Name the structure the blood vessel indicated flows into.
A. Lungs
B. Brain
C. Kidney
D. Ovary

13. Identify the blood vessel indicated.
A. Femoral vein
B. Popliteal vein
C. Anterior tibial vein
D. Fibular vein

14. Identify the blood vessel indicated.
A. Femoral Vein
B. Great saphenous vein
C. Small saphenous vein
D. Posterior tibial vein

15. Identify the blood vessel indicated.
A. Femoral artery
B. Popliteal artery
C. Anterior tibial artery
D. Posterior tibial artery

Appendix C

1. Name the space indicated.
A. Lateral ventricle
B. 3rd ventricle
C. 4th ventricle
D. 1st ventricle

2. Identify the structure indicated.
A. Hypothalamus
B. Corpus callosum
C. Precentral gyrus
D. Postcentral gyrus

3. Identify the structure indicated.
A. Thalamus
B. Hypothalamus
C. Pons
D. Medulla oblongata

4. Identify the structure indicated.
A. Cerebrum
B. Cerebellum
C. Brain stem
D. Diencephalon

5. Identify the structure indicated.
A. Midbrain
B. Medulla oblongata
C. Central sulcus
D. Cerebellum

6. Identify the structure indicated.
A. Hypothalamus
B. Thalamus
C. Midbrain
D. Pons

7. Name the space indicated.
A. Lateral ventricle
B. 3rd ventricle
C. 4th ventricle
D. 1st ventricle

8. Identify the structure indicated
A. Cauda equina

B. Conus medullaris
C. Postcentral gyrus
D. Precentral gyrus

9. Identify the neuron indicated.
A. Tibial
B. Phrenic
C. Vagus
D. Common fibular

10. Identify the neuron indicated.
A. Radial
B. Axillary
C. Ulnar
D. Musculocutaneous

11. Identify the neuron indicated.
A. Median
B. Ulnar
C. Musculocutaneous
D. Axillary

12. Identify the neuron indicated
A. Musculocutaneous
B. Median
C. Radial
D. Phrenic

13. Identify the neuron indicated.
A. Femoral
B. Tibial
C. Sciatic
D. Common fibular

14. Identify the neuron indicated.
A. Tibial
B. Phrenic
C. Common fibular
D. Sciatic

15. Identify the neuron indicated.
A. Common fibular
B. Tibial
C. Femoral
D. Sciatic

Appendix D

Question	Strongly Disagree	Disagree	Neither agree or disagree	Agree	Strongly agree
Perception of Learning Questions					
I am comfortable with online learning.	1	2	3	4	5
I am comfortable with Anatomy and Physiology Revealed program.	1	2	3	4	5
I learn anatomy when I learn by myself.	1	2	3	4	5
I learn anatomy better when I learn with others in the classroom.	1	2	3	4	5
I am a "hands-on" learner.	1	2	3	4	5
Virtual labs help in the study of anatomical structures.	1	2	3	4	5
Virtual labs help in the study of anatomical structures in a scenario where cadavers are lacking.	1	2	3	4	5
Cadavers help in the study of anatomical structures.	1	2	3	4	5
My lack of experience with virtual labs negatively affected my learning of anatomy?	1	2	3	4	5
Cadavers provide the real touch feeling of the human body.	1	2	3	4	5
Virtual labs provide the real touch feeling of the human body.	1	2	3	4	5
Virtual labs are preferable to studying cadavers.	1	2	3	4	5
Classroom labs are preferable to studying cadavers.	1	2	3	4	5
Virtual labs can replace dissected cadavers in teaching of anatomy.	1	2	3	4	5
Virtual labs provide important elements in learning anatomy.	1	2	3	4	5
Cadavers provide important elements in learning anatomy.	1	2	3	4	5
Virtual labs are a supplement to cadavers.	1	2	3	4	5
Virtual labs are useful in learning anatomy outside the classroom.	1	2	3	4	5
Virtual labs are useful in reviewing anatomy outside the classroom.	1	2	3	4	5
I learned more in the face-to-face labs as compared to the virtual labs.	1	2	3	4	5
I learned more in the virtual labs as compared to the face-to-face labs.	1	2	3	4	5
I was frustrated with the virtual labs experience.	1	2	3	4	5
I was frustrated with the face-to-face labs experience.	1	2	3	4	5
Satisfaction Questions					
I like the convenience of online learning.	1	2	3	4	5
I like learning in the online environment.	1	2	3	4	5
I like learning in the face-to-face environment.	1	2	3	4	5

I like learning through video.	1	2	3	4	5
I like learning through a lecture in the lecture classroom.	1	2	3	4	5
I like learning through a demonstration by a lecturer in the classroom lab.	1	2	3	4	5
I like that I can watch the videos on my own time.	1	2	3	4	5
I am satisfied with my learning in the virtual labs.	1	2	3	4	5
I am satisfied with my learning in the face-to-face labs.	1	2	3	4	5
I like the convenience of taking an exam online.	1	2	3	4	5

Appendix E

ADULT CONSENT FORM

IRB#: **Approval Date:** **Expiration Date:**

A Comparative Study in Learning Outcomes and Self-Perceived Learning in Anatomy Dissection this Research Study.

Invitation.
You are invited to take part in this research study. The information in this form is meant to help you decide whether or not to take part. If you have any questions, please ask.

Why are you being asked to be in this research study?
You are eligible because you are a student enrolled in Human Anatomy Bio 180.

What is the reason for doing this research study?
The purpose of this study is to examine learning outcomes from online anatomy dissection labs and face-to-face anatomy dissection labs. In addition, the research will explore self-perceive learning and satisfaction based upon the experience in the dissection labs.

What will be done during this research study?
You will participate as a student by will watching a pre-recorded 20-minute presentation about the topic being studied. For the next 85 minutes, you will have time to study the specimen using the information from the presentation. Approximately one week after the presentation, you will take an exam based upon the information from the presentation.
You will participate in both the face-to-face anatomy dissection lab and online dissection lab with the order being randomized.

Face-to-face anatomy dissection lab
This will occur at the Midwestern University in the anatomy lab using the cadavers in the lab. You will need to wear lab appropriate clothing to be in the lab. After you have watched the presentation, you will have time to study the cadaver based upon the information in the presentation. After one week, you will take the exam in the anatomy lab.

Participant Initials ________

ADULT Consent Form - PAGE TWO

Online anatomy dissection lab
This will occur at a time and place that is convenient to you. You will use a computer device with internet access in order to access the presentation and computer software for the online dissection lab. After you have watched the presentation, you will have time to study the virtual cadaver based upon the information in the presentation. After one week, you will take the exam at time and place convenient to you.

Self-perceived learning and satisfaction survey
At the completion after the exams, you will complete a survey that will be taken online.

What are the possible risks of being in this research study?
There are no known risks to you from being in this research study. However, talking about this topic may make you feel upset or uncomfortable. If you feel this way, tell your researcher so that they can provide you with support resources.

What are the possible benefits to you?
You are not expected to get any direct benefit from being in this research study

What are the possible benefits to other people?
The information gained will be helpful to contribute to future offerings of anatomy dissection labs in both face-to-face and online experiences. It will also contribute by gaining the perception of learning and satisfaction of these experiences.

What are the alternatives to being in this research study?
Instead of being in this research study you can choose not to participate

What will being in this research study cost you?
There is no cost to you to be in this research study.

Will you be paid for being in this research study?
You will not be paid or compensated for being in this research study.

What should you do if you have a concern during this research study?
Your well-being is the major focus of every member of the research team. If you have a concern as a direct result of being in this study, you should immediately contact one of the people listed at the end of this consent form.

How will information about you be protected?
Reasonable steps will be taken to protect your privacy and the confidentiality of your study data. The only persons who will have access to your research records are the study personnel, the Institutional Review Board (IRB), and any other person or agency required by law. The information from this study may be published in scientific journals or presented at scientific meetings but your identity will be kept strictly confidential.

Participant Initials ________

ADULT Consent Form - PAGE THREE

What are your rights as a research participant?
You have rights as a research participant. These rights have been explained in this consent form and in The Rights of Research Participants that you have been given. If you have any questions concerning your rights, talk to the investigator or call the Institutional Review Board (IRB), telephone (402)-399-2400.

What will happen if you decide not to be in this research study or decide to stop participating once you start?
You can decide not to be in this research study, or you can stop being in this research study ("withdraw") at any time before, during, or after the research begins. Deciding not to be in this research study or deciding to withdraw will not affect your relationship with the investigator, or with the College of Saint Mary (also add any other sites to this statement, if needed).

You will not lose any benefits to which you are entitled.

If the research team gets any new information during this research study that may affect whether you would want to continue being in the study, you will be informed promptly.

Documentation of informed consent.
You are freely making a decision whether to be in this research study. Signing this form means that (1) you have read and understood this consent form, (2) you have had the consent form explained to you, (3) you have had your questions answered and (4) you have decided to be in the research study.

If you have any questions during the study, you should talk to one of the investigators listed below. You will be given a copy of this consent form to keep.

If you are 19 years of age or older and agree with the above, please sign below.

Signature of Participant: Date: Time:

My signature certifies that all the elements of informed consent described on this consent form have been explained fully to the participant. In my judgment, the participant possesses the legal capacity to give informed consent to participate in this research and is voluntarily and knowingly giving informed consent to participate.

Signature of Investigator: Date:

Participant Initials _______

ADULT Consent Form - PAGE FOUR

Authorized Study Personnel. Identify all personnel authorized to document consent as listed in the IRB Application. Use the following subheadings: Principal Investigator, Secondary Investigator(s), and Participating Personnel. Include day phone numbers for all listed individuals.

Principal Investigator: ______________________________ Phone: _____________

Secondary Investigator: ____________________________ Phone: _____________
(This could be your research advisor)

7000 Mercy Road • Omaha, NE 68106-2606 • 402.399.2400 • FAX 402.399.2341 • www.csm.edu

Date: XXXXXXXXXXX

A Comparative Study in Learning Outcomes and Self-Perceived Learning in Anatomy Dissection

IRB #

Dear Bio 180 student,

You are invited to take part in a research study because you are enrolled in Bio 180 Human Anatomy. The purpose of this study is to examine learning outcomes of exams from online anatomy dissection lab and face-to-face anatomy dissection lab. In addition, this research will explore self-perceived learning and satisfaction of participants. This research study is being conducted as part of the requirements of my doctoral program at College of Saint Mary.

You may receive no direct benefit from participating in this study, but the information gained will be helpful to contribute to future offerings of anatomy dissection labs in both face-to-face and online experiences. It will also contribute by gaining the perception of learning and satisfaction of these experiences.

Should you decide to participate you are being asked to complete the following on-line survey which should take approximately 10 minutes to complete. At the end of the research, you will be asked to complete another survey that will take approximately 15 minutes. Your participation is strictly voluntary. Furthermore, your response or decision not to respond will not affect your relationship with College of Saint Mary or any other entity. Please note that your responses will be used for research purposes only and will be strictly confidential. No one at College of Saint Mary will ever associate your individual responses with your name or email address. The information from this study may be published in journals and presented at professional meetings.

You may withdraw at any time by exiting the survey. This study does not cost the participant in any way, except the time spent completing the survey. There is no compensation or known risk associated with participation.

Please read *The Rights of Research Participants* below. If you have questions about your rights as a research participant, you may contact the College of Saint Mary Institutional Review Board, 7000 Mercy Road, Omaha, NE 68144 (402-399-2400).

Thank you sincerely for participating in this important research study. If you have comments, problems or questions, please contact the researcher(s).

Sincerely,

Jenna L. Davidson

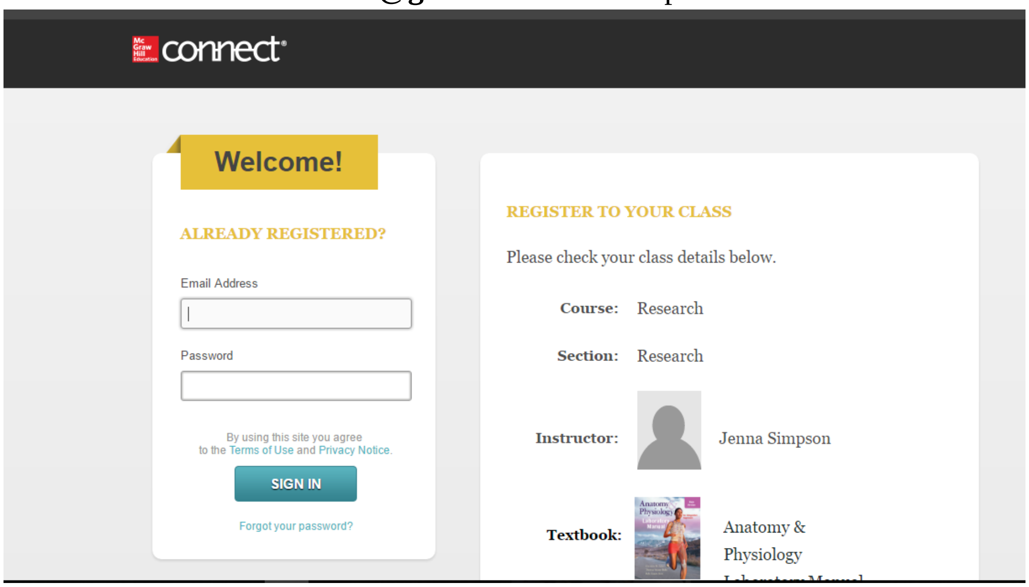
Appendix F

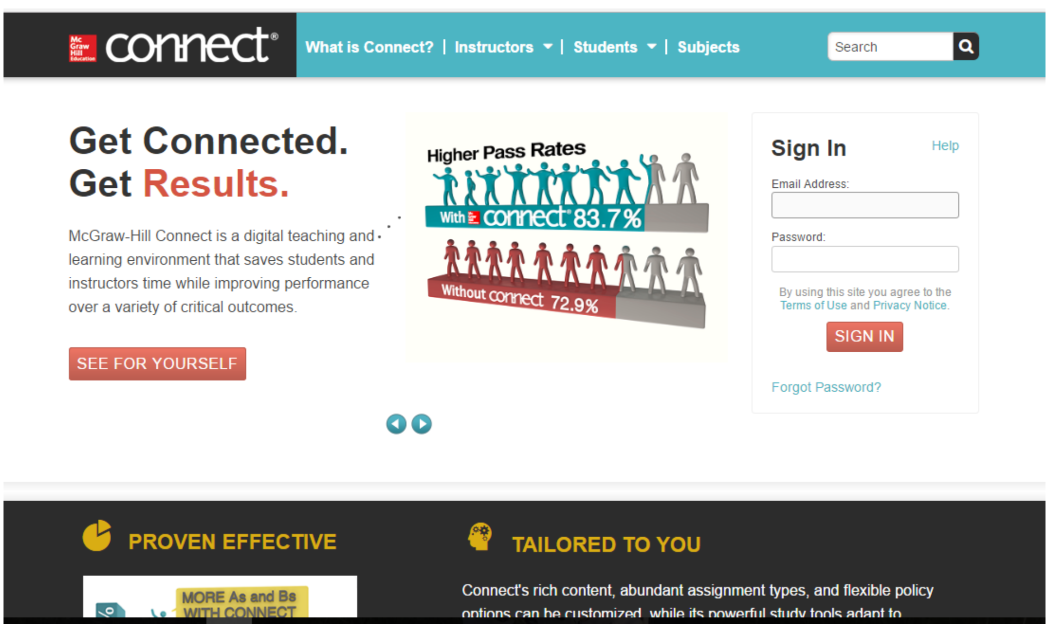
Lab Directions

1. You will use the McGraw-Hill Virtual Dissection product known as "Anatomy & Physiology Revealed".
2. You will use the "Dissection" tool and look at images that highlight the specific structures you will need to know.
3. You can spend up to 85 minutes in the dissection.
4. Please let Jenna know if you have any issues.

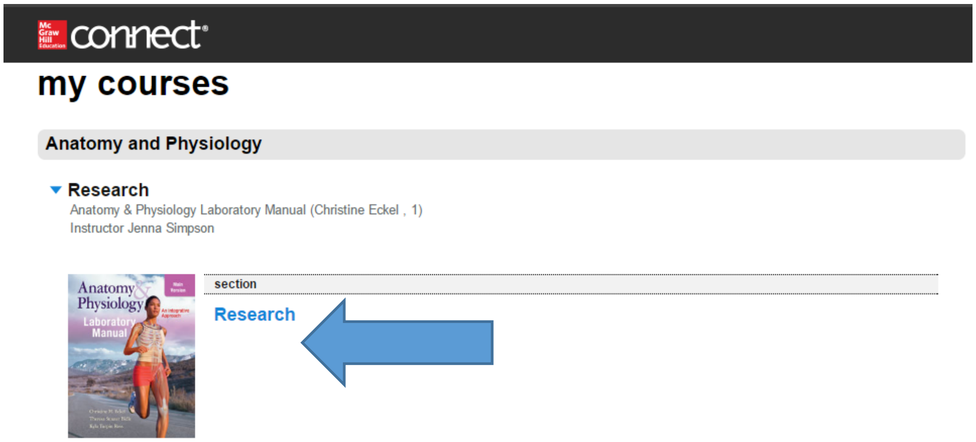
STEPS TO LOGIN

1. Search for "McGraw-Hill Connect". The email address is: **researchstudent0@gmail.com** and the password is: **Research2016**



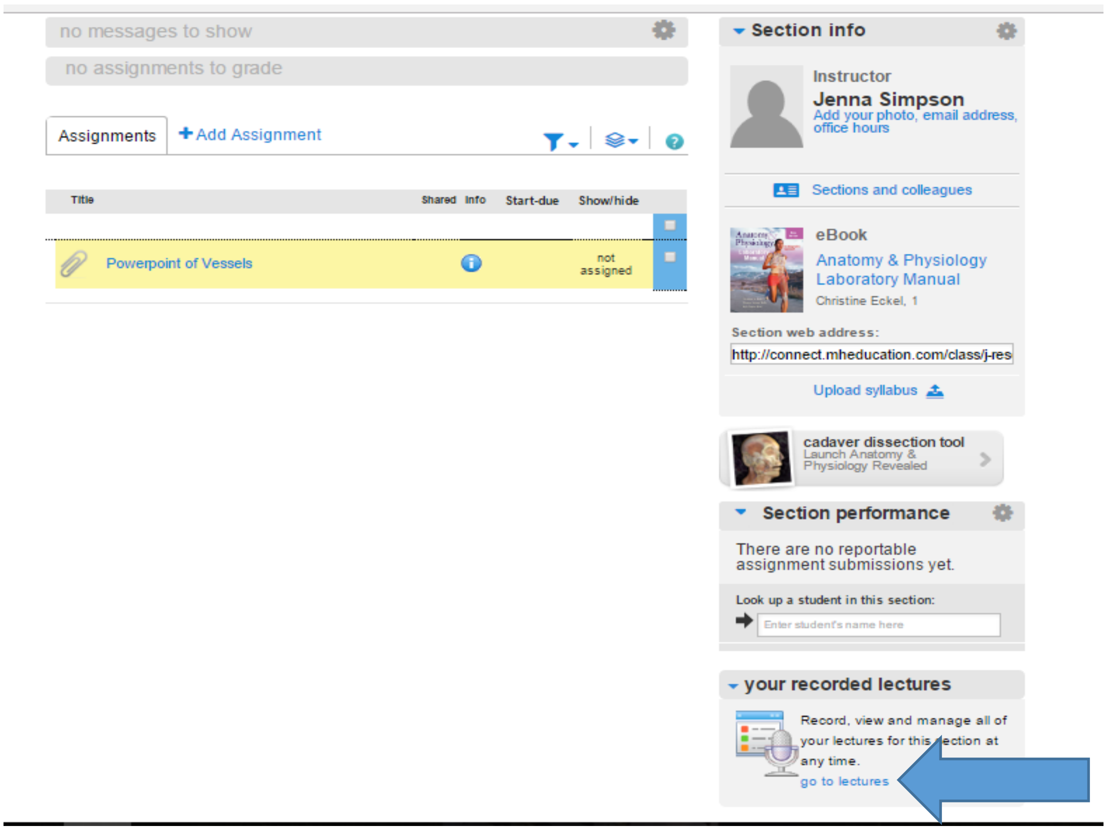


2. Once you are in the course, you will see this screen. You will want to click on the blue "Research" word.

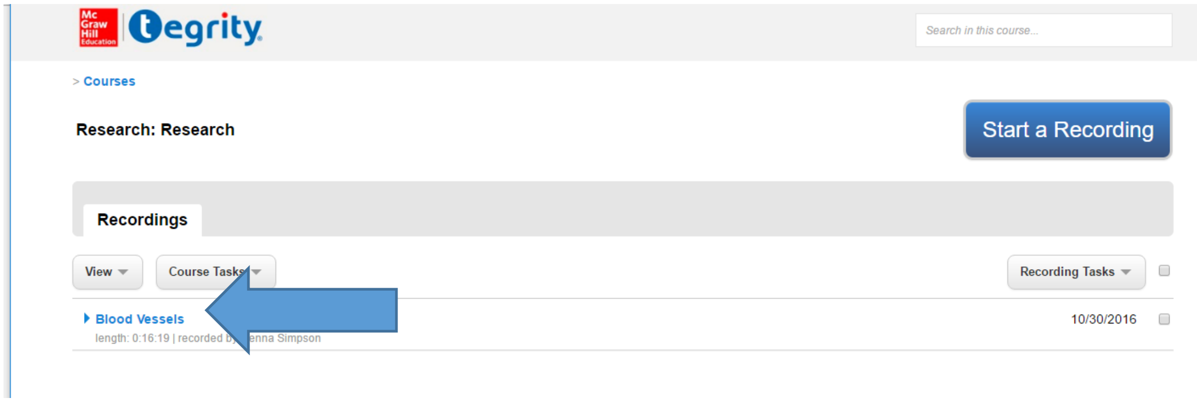


STEPS FOR LECTURE

1. After logging into the course, go to "your recorded lectures" and click on the blue "go to lectures" link.

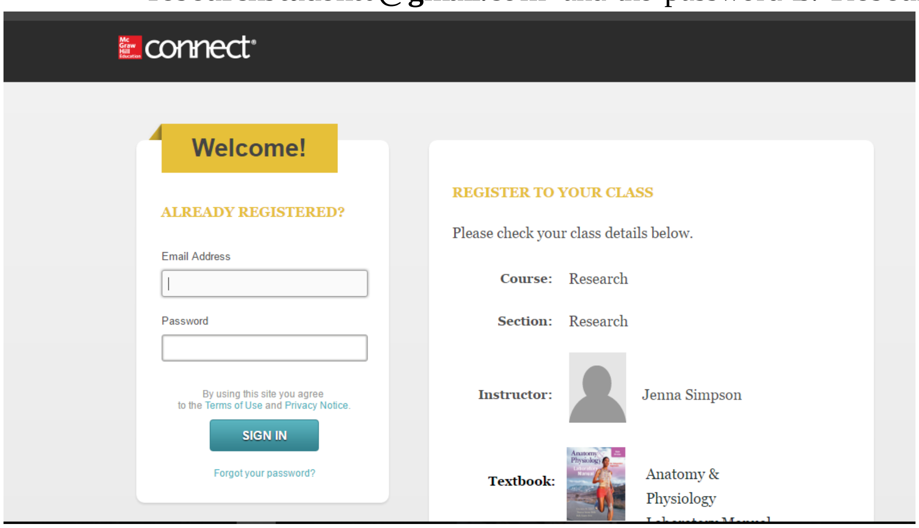


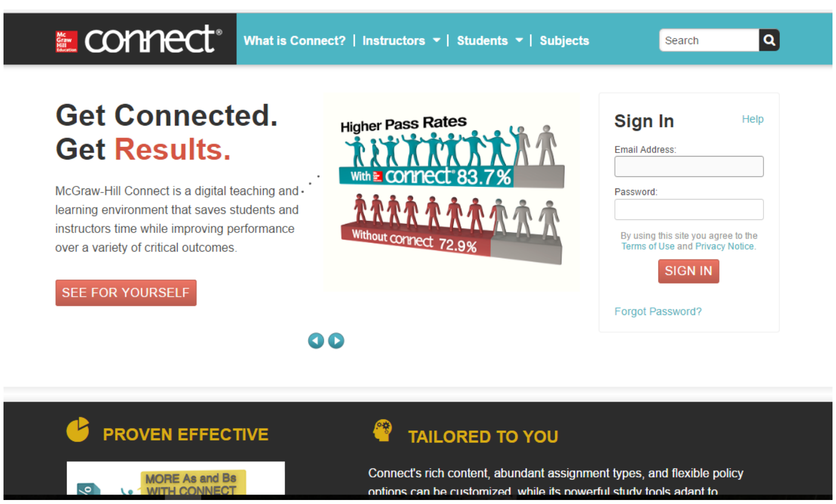
2. You may have to click "Yes" or a screen will say the lectures are loading. Then you will see this screen. Click on the "Blood Vessels" blue link to watch the lecture.



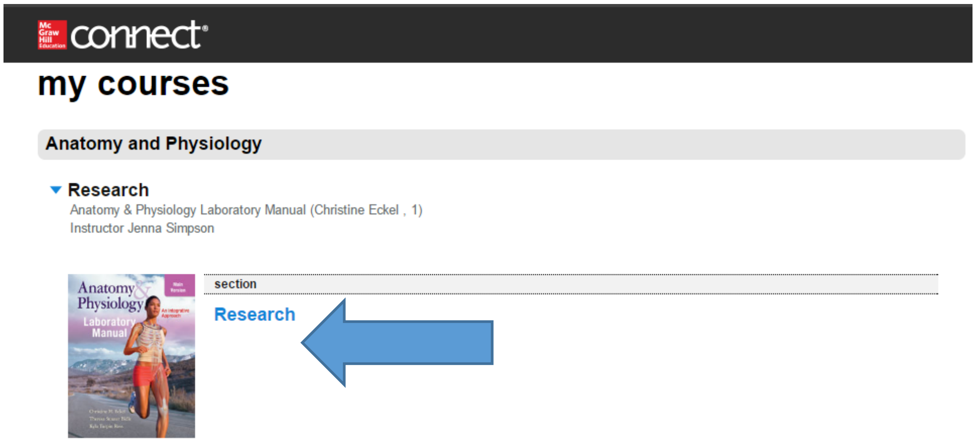
STEPS TO LOGIN

3. Search for "McGraw-Hill Connect". The email address is: **researchstudent0@gmail.com** and the password is: **Research2016**

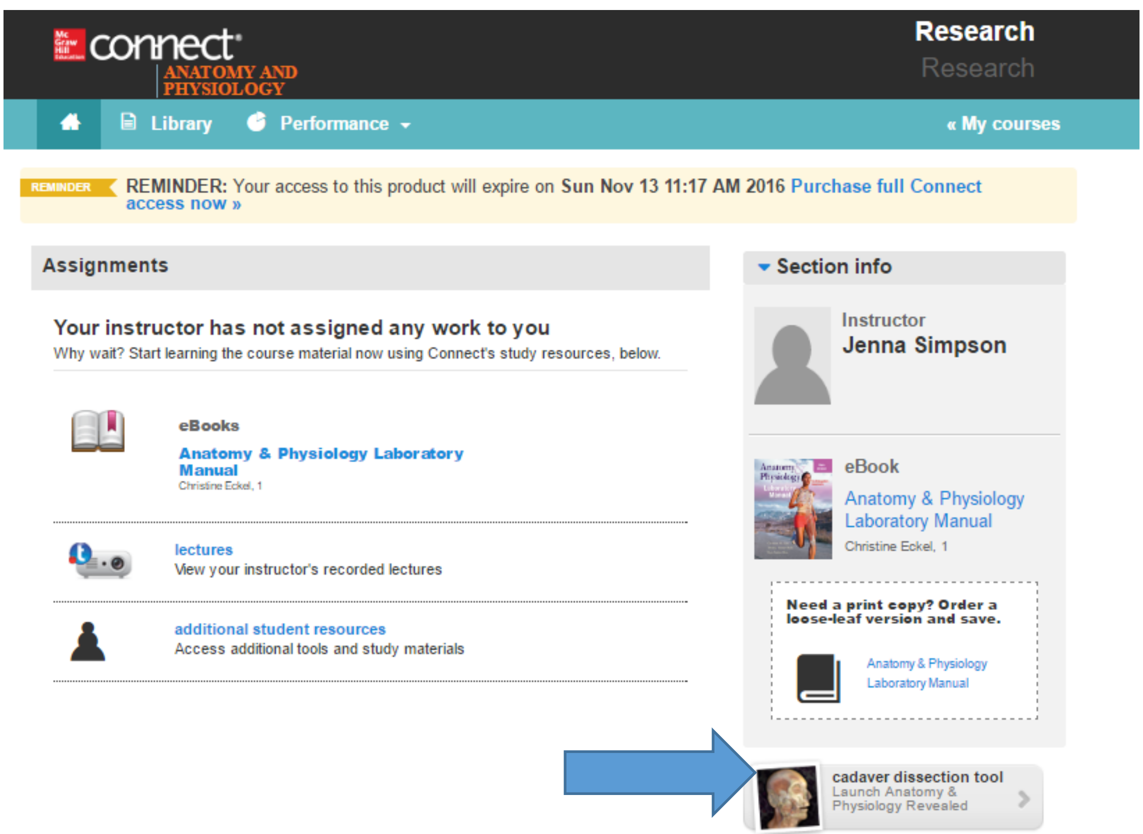




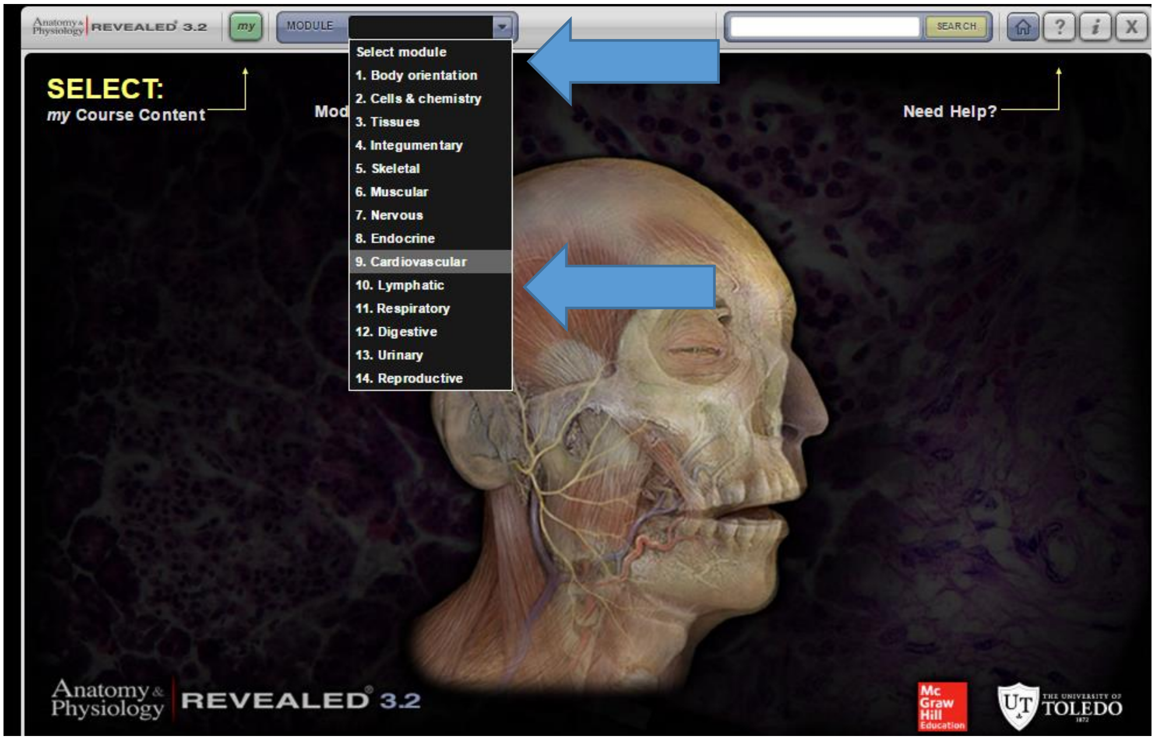
4. Once you are in the course, you will see this screen. You will want to click on the blue "Research" word.



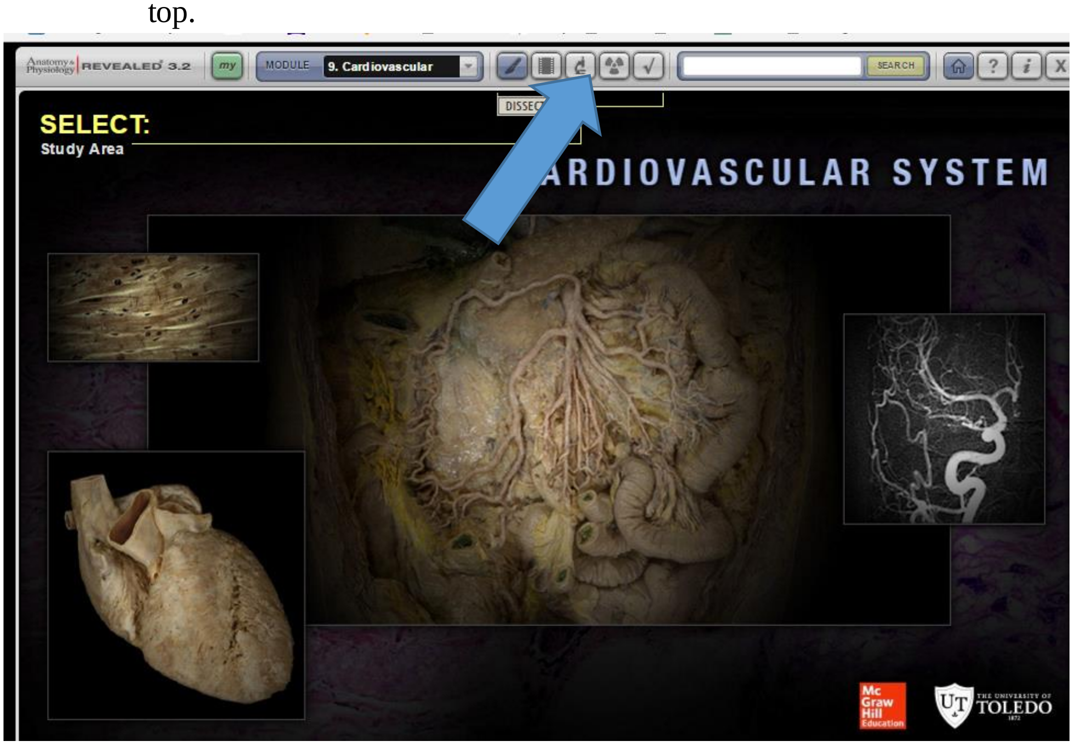
5. Then you will be at the "Research Course" home page. You will want to click the "Cadaver Dissetion tool – Launch Anatomy & Physiology Revealed".



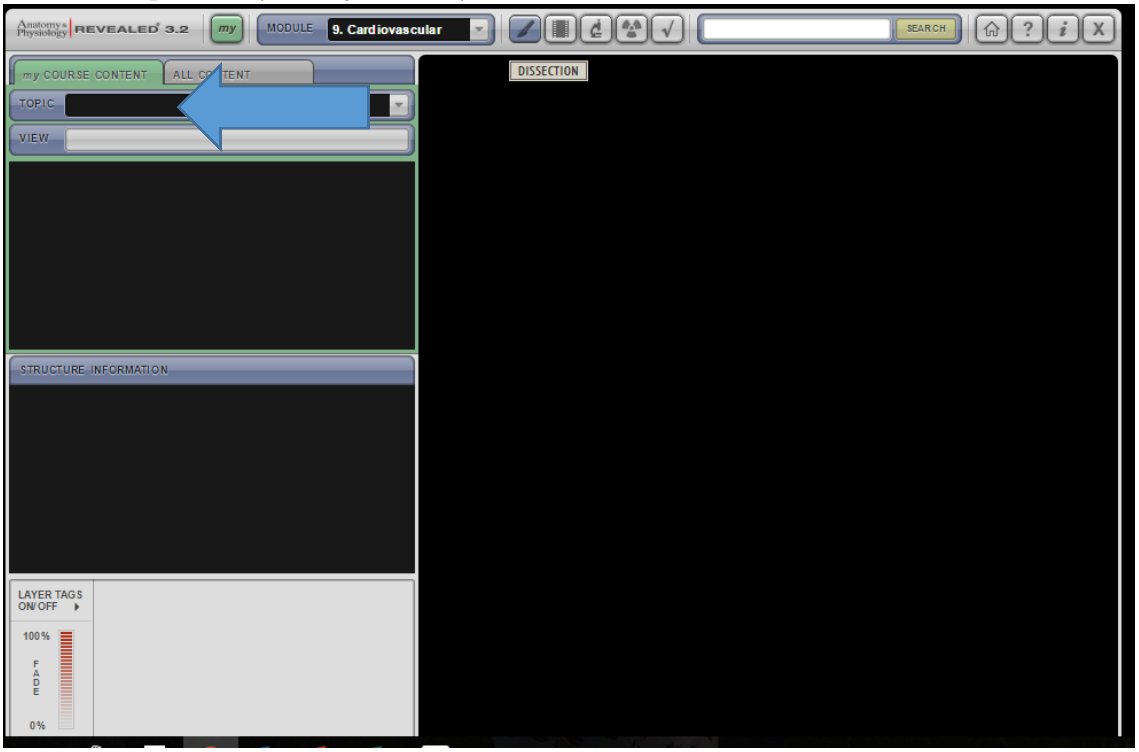
6. Once it has luanched, you will see this screen. You will want to select from "Module" the "Cardiovascular" option.



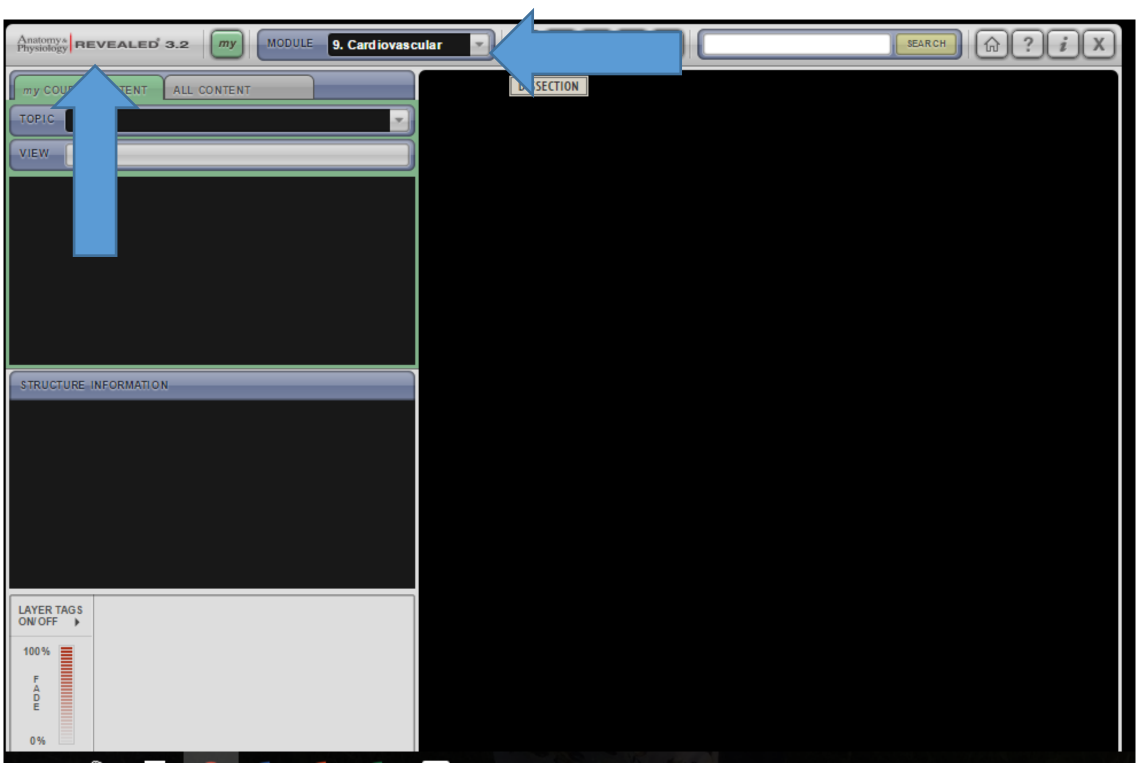
7. Then you will see this screen. You will need to select the "Dissection" tool at the top.



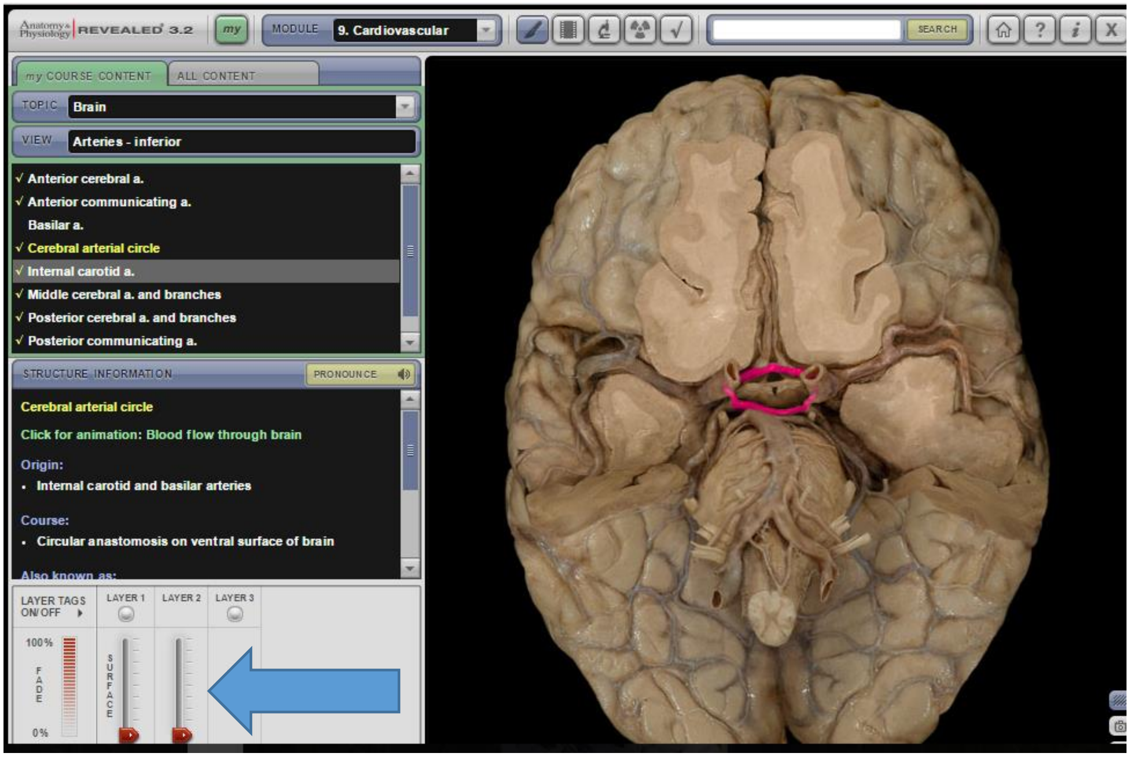
8. Then you are at this screen. Make sure the green "*my* Course Content" has been selected (Meaning this is the front tab, which it should be). This Cardiovascular module is specifically designed for you to look at certain vessels.



9. With the drop-down tab under "Topic" select one of the areas of the body. With some of the "Topic" selected, you will need to choose "View."



10. Enjoy look at the structures and the various views. Your quiz will be based off of these views. Here is a sample. You can also play with the "Layer" options in the bottom left.



Appendix G

Lab Directions

1. You will use the McGraw-Hill Virtual Dissection product known as "Anatomy & Physiology Revealed".
2. You will use the "Dissection" tool and look at images that highlight the specific structures you will need to know.
3. You can spend up to 85 minutes in the dissection.
4. Please let Jenna know if you have any issues.

STEPS TO LOGIN

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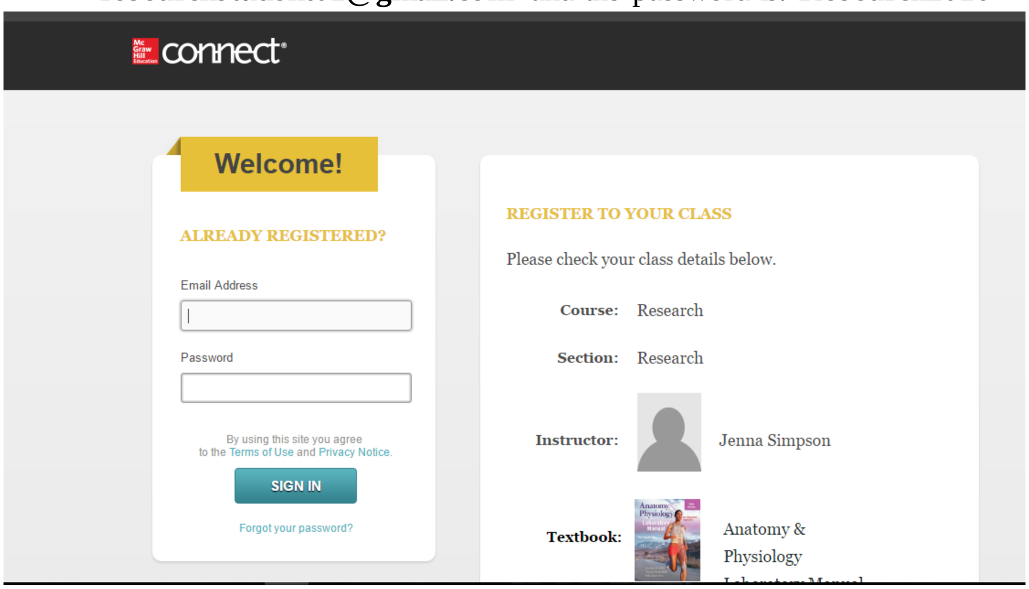
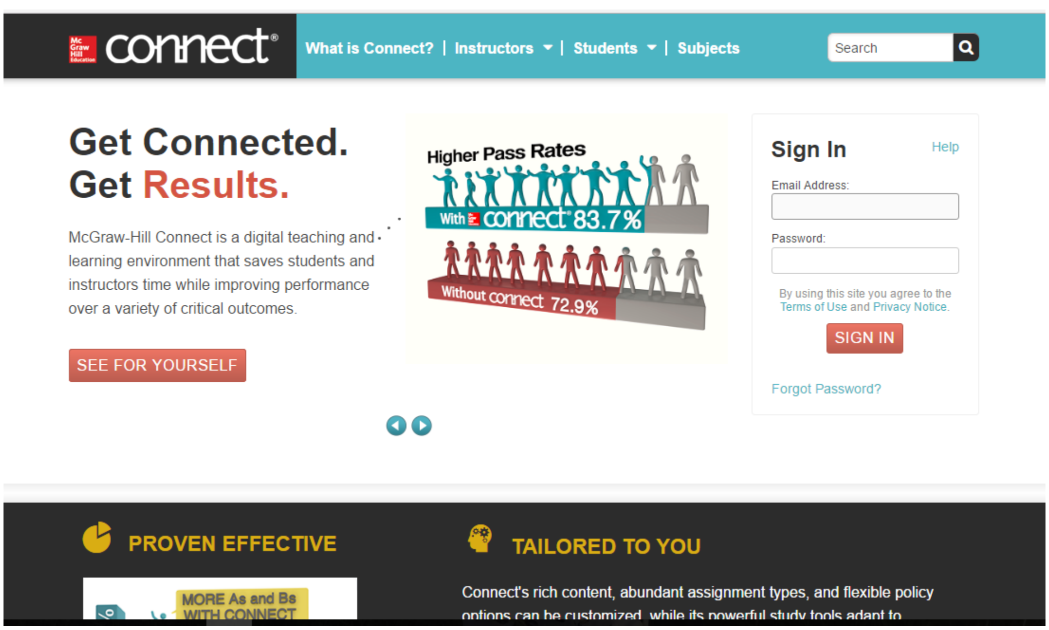
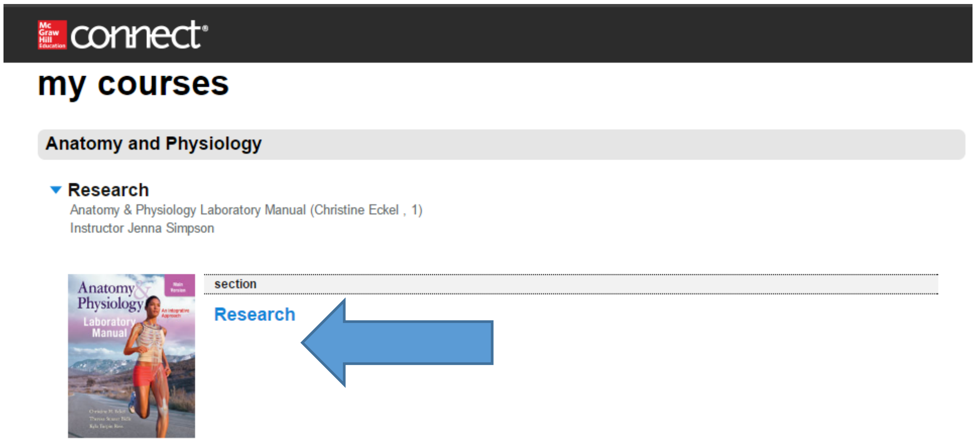


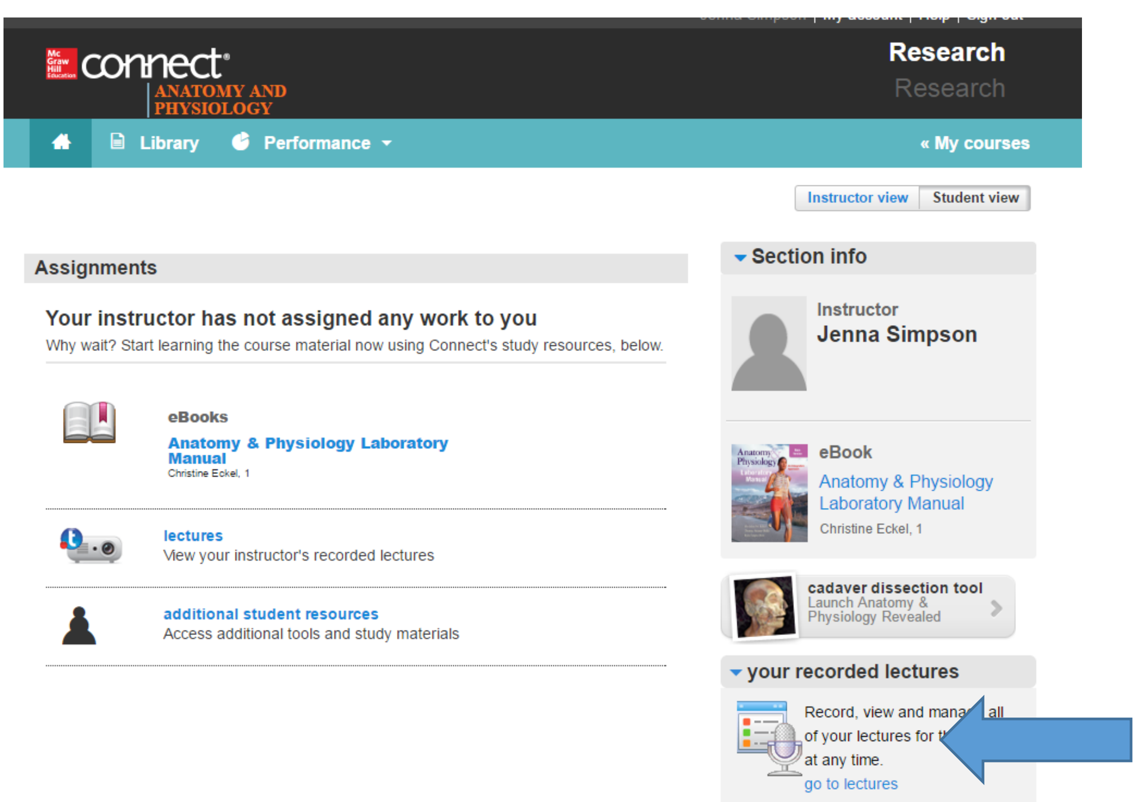


2. Once you are in the course, you will see this screen. You will want to click on the blue "Research" word.

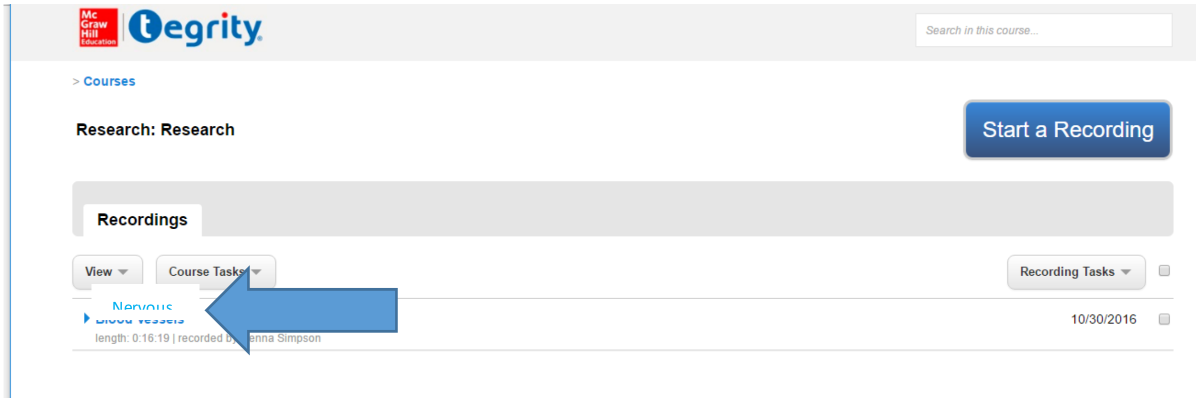


STEPS FOR LECTURE

3. After logging into the course, go to "your recorded lectures" and click on the blue "go to lectures" link.

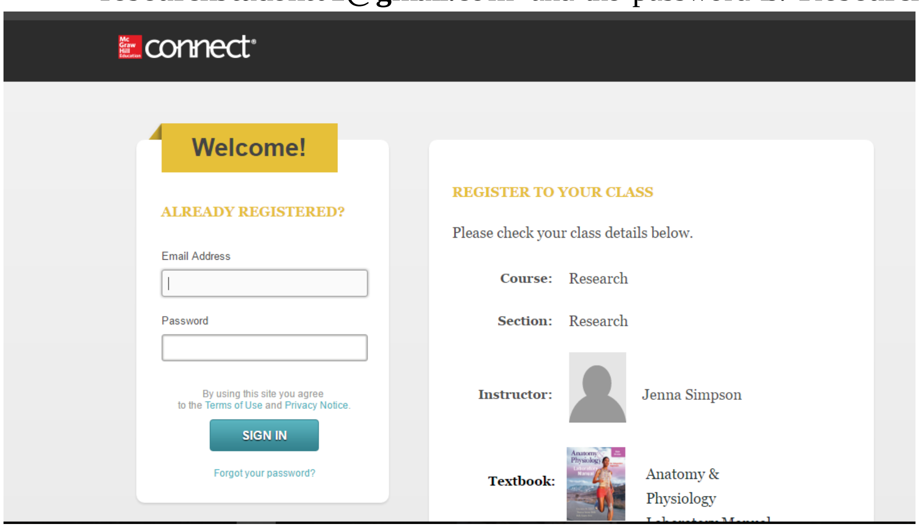


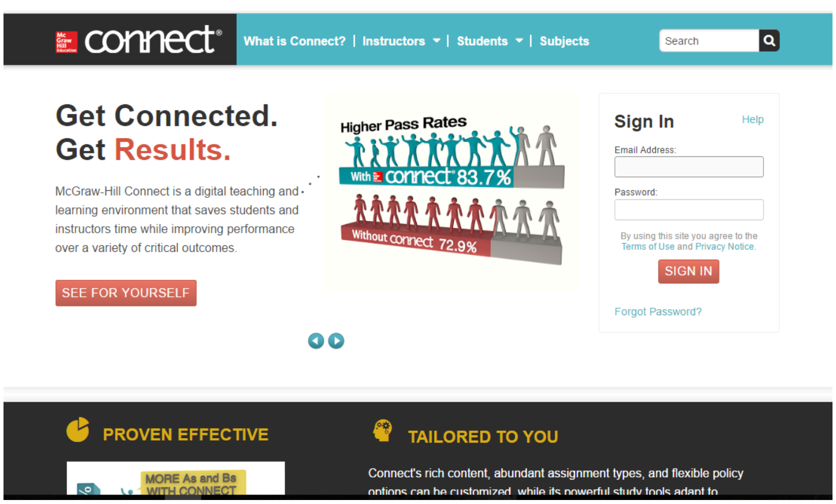
4. You may have to click "Yes" or a screen will say the lectures are loading. Then you will see this screen. Click on the "Nervous" blue link to watch the lecture.



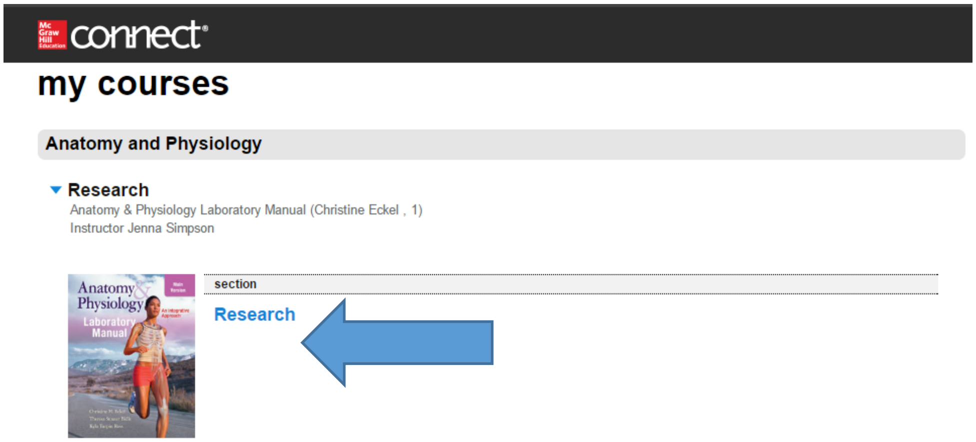
STEPS TO LOGIN

5. Search for "McGraw-Hill Connect". The email address is: **researchstudent01@gmail.com** and the password is: **Research2016**

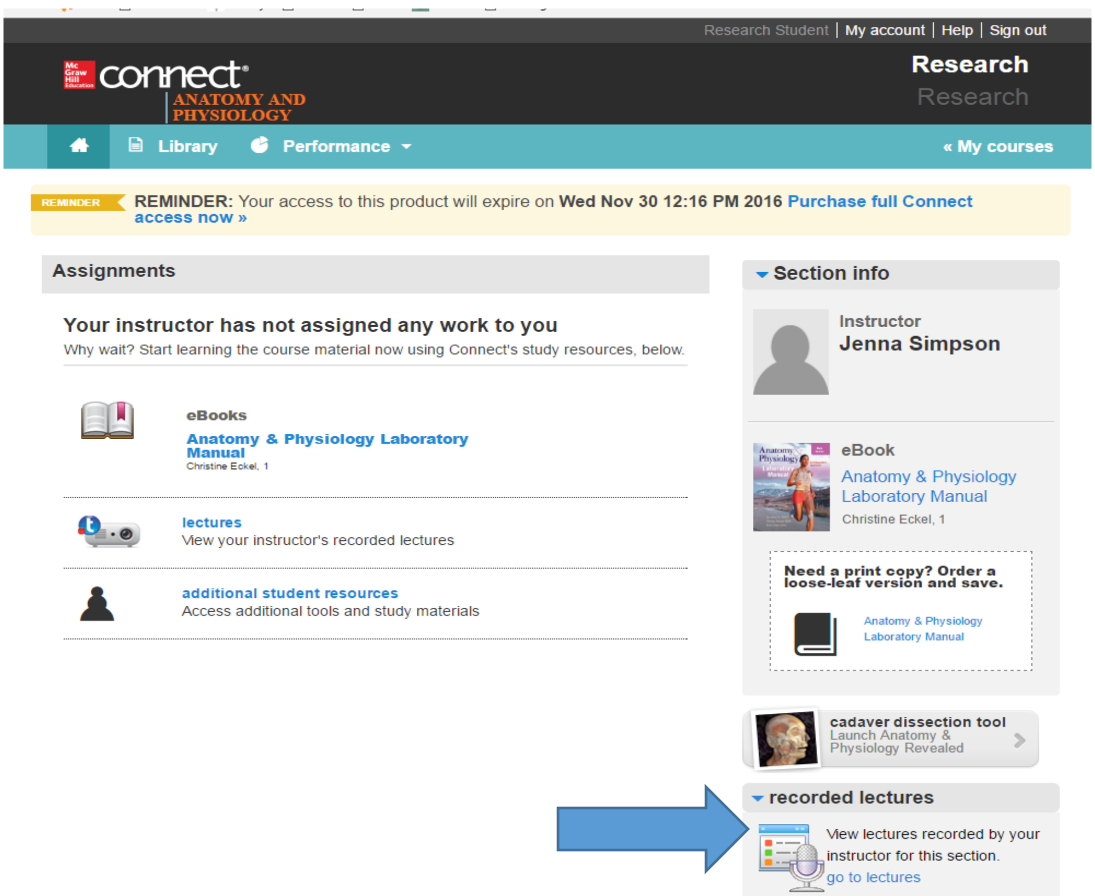




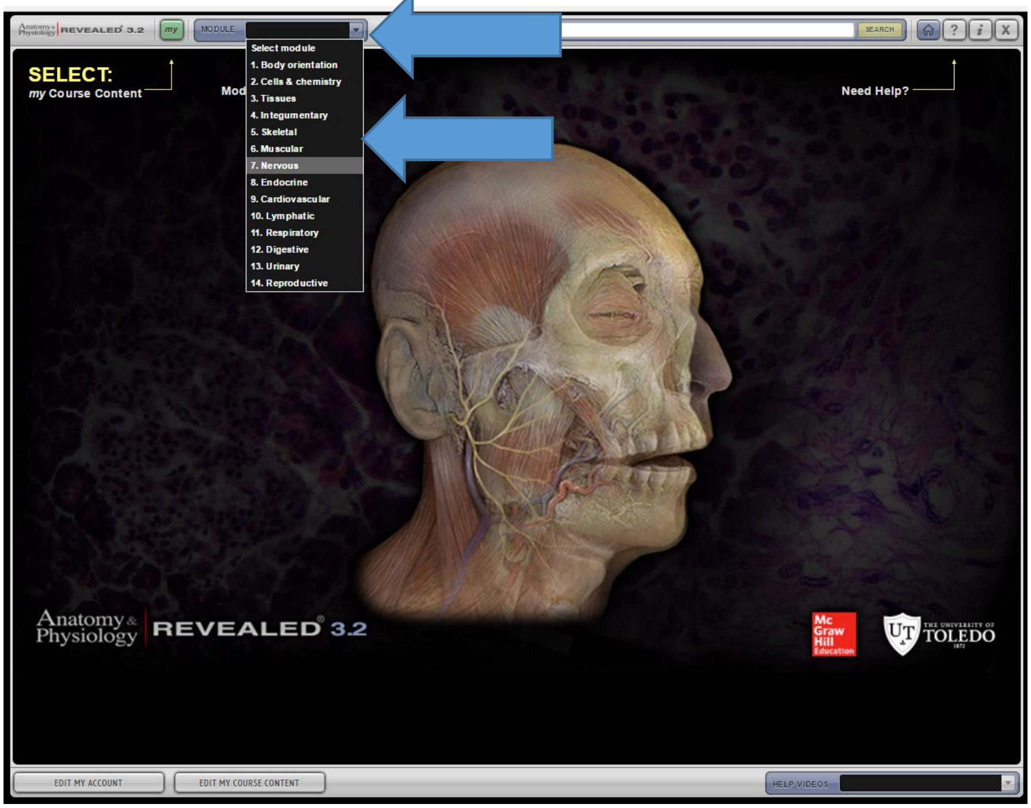
6. Once you are in the course, you will see this screen. You will want to click on the blue "Research" word.



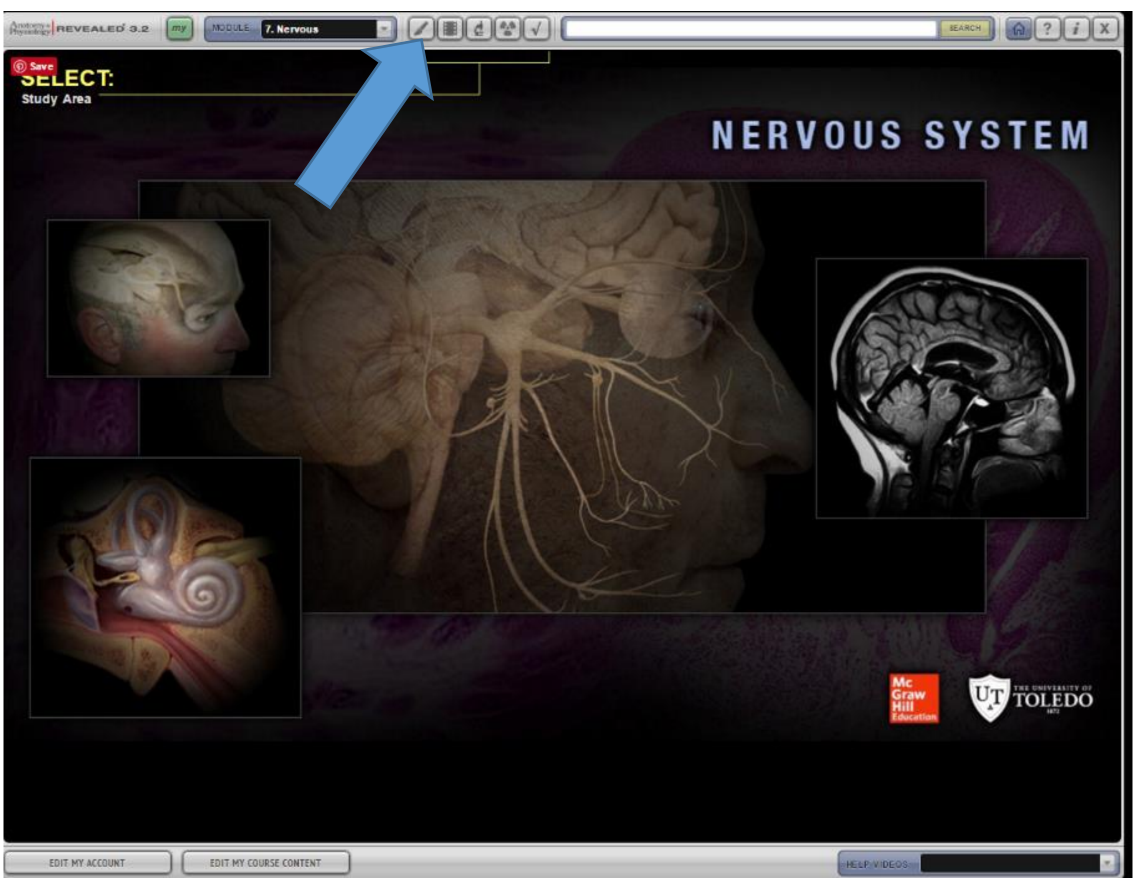
7. Then you will be at the "Research Course" home page. You will want to click the "Cadaver Dissetion tool – Launch Anatomy & Physiology Revealed".



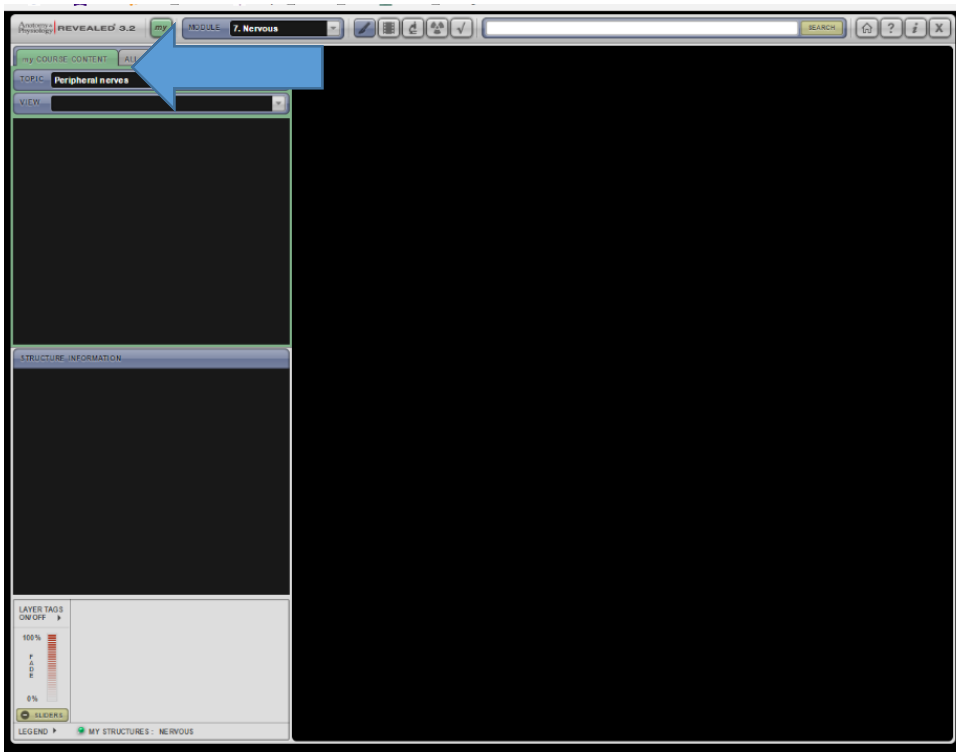
8. Once it has luanched, you will see this screen. You will want to select from “Module” the “Nervous” option.



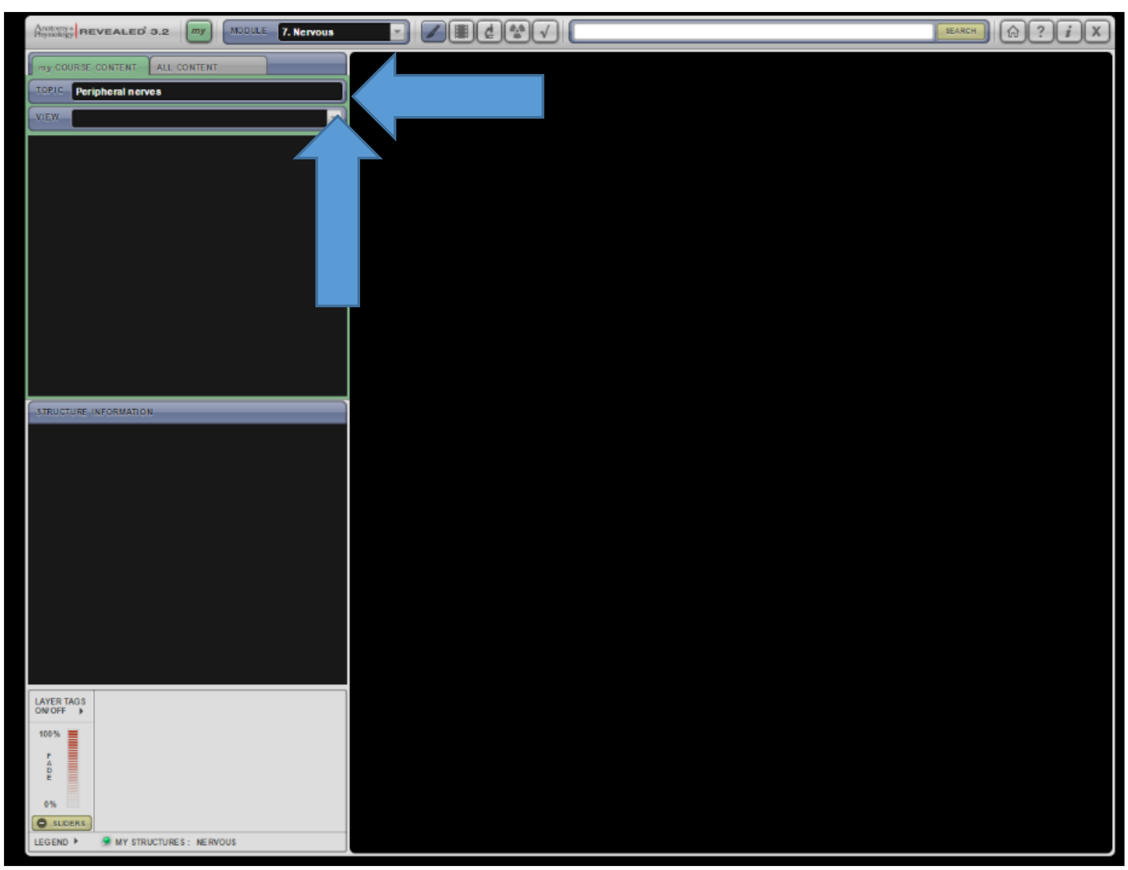
9. Then you will see this screen. You will need to select the “Dissection” tool at the top.



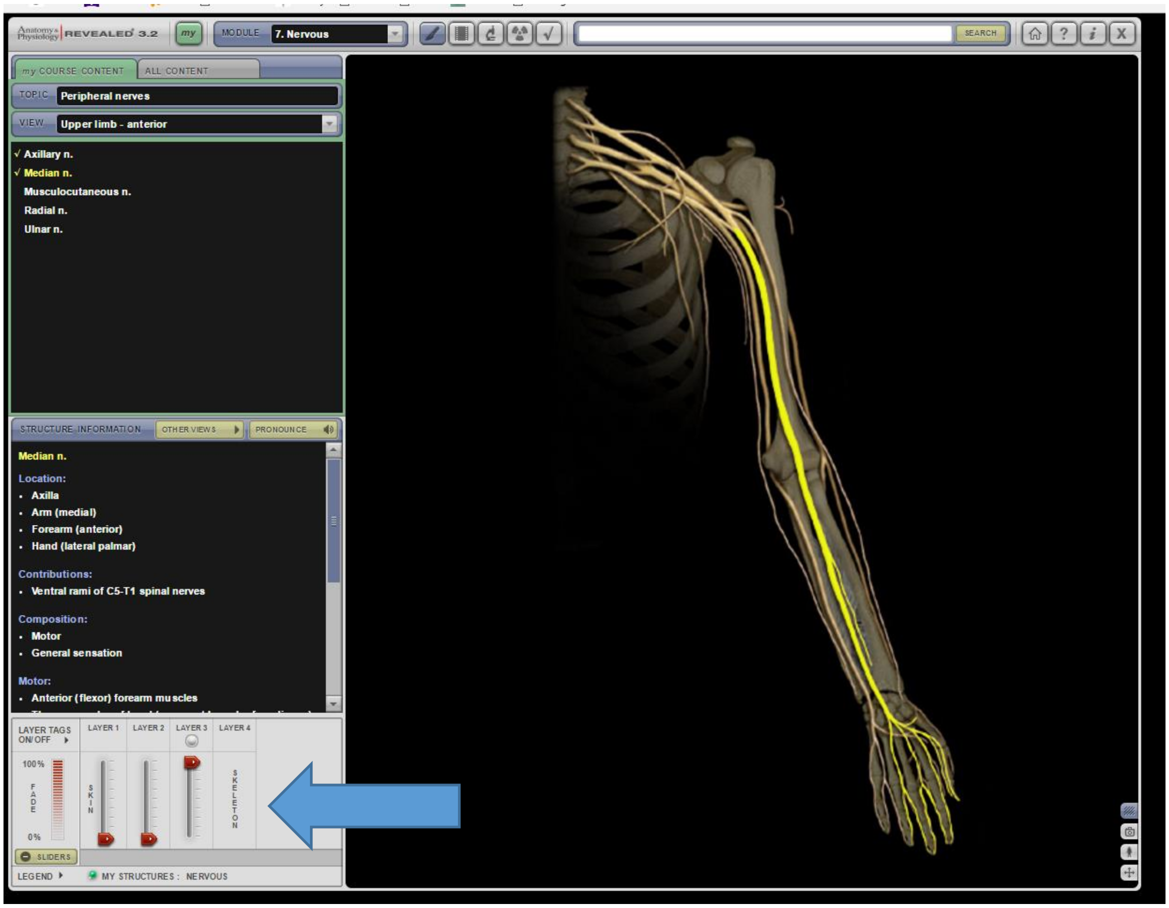
10. Then you are at this screen. Make sure the green "*my* Course Content" has been selected (Meaning this is the front tab, which it should be). This Nervous module is specifically designed for you to look at certain structures.



11. With the drop-down tab under "Topic" select one of the areas of the body. With some of the "Topic" selected, you will need to choose "View."



12. Enjoy looking at the structures and the various views. Your quiz will be based off of these views. Here is a sample. You can also play with the "Layer" options in the bottom left.



Appendix H

COLLEGE OF SAINT MARY

October 3, 2016

Dear Ms. Davidson,

Congratulations! The Institutional Review Board at College of Saint Mary has granted approval of your study titled *Online and Face-to-Face anatomy dissection labs: A comparison of levels of achievement in learning outcomes and perception of learning and satisfaction.*

Your CSM research approval number is **CSM 1613**. It is important that you include this research number on all correspondence regarding your study. Approval for your study is effective through December 1, 2017. If your research extends beyond that date, please submit a “Change of Protocol/Extension” form which can be found in Appendix B at the end of the College of Saint Mary Application Guidelines posted on the IRB Community site.

Please submit a closing the study form (Appendix C of the IRB Guidebook) when you have completed your study.

Good luck with your research! If you have any questions or I can assist in any way, please feel free to contact me.

Sincerely,

Vicky Morgan

Dr. Vicky Morgan
Director of Teaching and Learning Center
Chair, Institutional Review Board * irb@csm.edu

7000 Mercy Road • Omaha, NE 68106-2606 • 402.399.2400 • FAX 402.399.2341 • www.csm.edu

Appendix I

MERCY MEDICAL CENTER
DES MOINES
A member of Mercy Health Network

1111 – 6th Avenue

Des Moines, Iowa 50314

October 7, 2016

Jenna Davidson, MS

RE: Online and Face-to-Face Anatomy Dissection Labs: A Comparison of Levels of Achievement in Learning Outcomes and Perception of Learning and Satisfaction - Expedited Approval Study ID#: MMC2016-60FR

Dear Ms. Davidson,

On October 7, 2016, as interim IRB Vice-chairman, I reviewed your submission for facilitated review of the following research:

Online and Face-to-Face Anatomy Dissection Labs: A Comparison of Levels of Achievement in Learning Outcomes and Perception of Learning and Satisfaction

This study has been reviewed and is approved to take place at Mercy Medical Center, with College of St. Mary acting as the IRB of record. This submission will be included on the Agenda for the 11/18/2016 IRB meeting for notification to the full board.

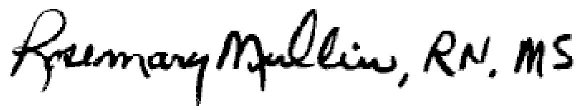
The IRB of record is responsible for all subsequent reviews; however, the following must be submitted to the Mercy Medical Center Des Moines IRB for board notification:

- Annual progress report;
- Local protocol deviations;
- Local unanticipated problems/serious adverse events;
- Approval documentation for amendments approved by the IRB of record and any revised documents (e.g. Informed Consent, Protocols); and/or
- Study closure documentation.

Should you have any questions regarding this letter approving facilitated review of your study, please feel free to contact our offices at (515) 247-3985.

This IRB operates in accordance with all local and federal applicable laws, regulations, and guidelines for research. Compliance is maintained with the FDA Code of Federal Regulations, Office for Human Rights Protections (OHRP), Good Clinical Practice (GCP) guidelines, and International Conference of Harmonization (ICH). All documentation is maintained in the study file per FDA/DHHS Regulations and IRB Guidelines.

Sincerely,



Rosemary Mullin, RN MS

Mercy Med Ctr – Des Moines IRB Interim Vice Chair