Learning Styles of Undergraduate Students and Its Influence on the Preference of Lecture Delivery Method in a Large Enrollment Undergraduate Gross Anatomy Course

DISSERTATION

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Abstract

Educators and researchers recognize that each individual prefers their own different learning styles. Learning styles are defined as a set of factors that aid individuals in learning. Knowing one's learning styles can help develop study strategies to compensate for weaknesses and capitalize on strengths. Providing students, especially students in the beginning of their collegiate career, tools to aid in their learning experience can assist in setting them up for success. This study investigates the unique nature of anatomy courses by examining the preferred learning styles of undergraduate anatomy students, as well as their lecture delivery method of choice throughout the course.

Students enrolled in Anatomy 2300 *Human Anatomy*, a large enrollment undergraduate anatomy course offered through the Division of Anatomy at The Ohio State University – Columbus Campus, were given the opportunity to complete the Index of Learning Styles (ILS) questionnaire developed by Drs. Richard Felder and Barbara Solomon, along with a short demographics survey. Afterwards, each participant was provided with their personalized learning styles scores on each of the four dimensions of learning styles (i.e. active/reflective, sensing/intuitive, visual/verbal, and sequential/global; as indicated by the ILS questionnaire), as well as information about study strategies for each of the four dimensions. Additional data collected included

lecture delivery method of choice, demographic information, highest ACT composite scores, and anatomy written examination scores.

Data analyses indicated that the students enrolled in Anatomy 2300 *Human Anatomy* were generally active, sensing, visual, and sequential learners, although a learning styles profile was constructed for the students in each of the declared majors/programs enrolled in the course which showed minor variation in the active/reflective dimension. In terms of gender differences for learning styles, statistical analyses indicated that females preferred an active learning style more so over males, who preferred a reflective learning style, while there was no statistical difference when comparing the genders in the other learning style dimensions. The results of the study also indicated that academic achievement, when controlling for academic ability, was only statically predicted by the active/reflective dimension in the head and neck curricular unit. Results of the different lecture delivery method choices indicated that for all three units, the most commonly chosen lecture delivery method was the online only method, followed by face-to-face only, and, lastly the mixture of both online and face-to-face. It was also found that only the sensing/intuitive dimension was statistically significant in predicting the lecture delivery method. The results also indicated individuals who utilized the face-to-face only lecture delivery method had higher examination scores over those who chose either of the other methods. There was no difference between the genders and their lecture delivery method of choice, although results indicated that there was a difference between the Pre-Nursing and Pre-Medicine

majors, as well as between the Pre-Nursing and Pre-Health Science majors in their choice of lecture delivery method.

Implications for anatomy instructors, undergraduate students, and future research are discussed.

This dissertation is dedicated to my parents and sister. They have continuously supported me in my endeavors, always encouraging me to reach for the stars. I cannot fully express how much love and gratitude I have for them. I also dedicate this document to my fur baby, Dexter, who always brightened by day when things got tough. Finally, I want to dedicate this to my friends, who have supported me through and through.

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Fields of Study

Major Field: Anatomy

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Abbreviations

ACT	American College Testing assessment
ACT/REF	Active/Reflective Dimension
ILS	Index of Learning Styles
LDM	Lecture Delivery Method
LS	Learning Style
SAT	Scholastic Aptitude Test
SEN/INT	Sensing/Intuitive Dimension
SEQ/GLO	Sequential/Global Dimension
Unit I	Overview of Body Systems and the Lower Limb
Unit II	The Back and Upper Limb
Unit III	The Head and Neck
Unit IV	The Abdomen, Pelvis, and Thorax
VARK	Visual, Auditory, Read/Write, and Kinesthetic
VIS/VER	Visual/Verbal Dimension

Chapter 1: Introduction

Anatomy is unique in that it requires the ability to perceive structures in three dimensions and often has a hands-on laboratory to reinforce these issues. Hence, this study was conducted in order to determine if Anatomy at the undergraduate level was any different than the other sciences and/or non-sciences in terms of student learning styles and lecture delivery method.

Accounting for individual learning styles is not a new idea. As early as 334 BC, Aristotle said that "each child possessed specific talents and skills" and he noticed individual differences (i.e., human personality traits) in young children (Cambiano, De Vore, & Harvey, 2001). There have been numerous research studies on learning styles and, thus, there are equally numerous definitions, theoretical positions, tools, instruments, and interpretations in which learning styles can be defined, classified, and identified. Therefore, sorting through the research and settling on a definition, as well as an instrument is a complex task. Generally, learning styles are overall patterns that provide direction to learning and teaching to the learner and instructor, respectively. Learning styles can also be described as a set of factors, behaviors, and attitudes that facilitate learning for an individual in a given situation (Cassidy, 2004). As such, it is no surprise that students learn and process information in many different ways. Learning style instruments (or tools) are continuously being developed as new theoretical framework is

constructed and research is conducted. Currently, the literature identifies 71 instruments, tools, and/or models of learning styles (Coffield, Moseley, Hall, & Ecclestone, 2004). In terms of research looking at learning styles, Coffield *et al*. (2004) recognized that the field is characterized "by a very large number of small-scale applications of particular models to small samples of students in specific contexts" (p. 1).

An area where there has been a noticeable lack of learning styles research has been within the scope of the undergraduate gross anatomy curriculum. Anatomy is the study of the body's structure and is at the core of the health professions by educating students about the intricacies of the human body (Wright, 2012). The information taught in gross anatomy is the foundation upon which all health professionals build their knowledge. Currently studies examining learning styles have primarily focused on medical students (Daud, Kashif, & Chaudhry, 2014; Johnson, 2009; Khalid, Rahim, Bashir, & Hanif, 2015; Lujan & DiCarlo, 2006). However, many health professional undergraduate, graduate, and professional programs either have or are beginning to require an anatomy prerequisite, as students need to develop a strong and broad understanding of the body's architecture in order to succeed in their chosen field (Wilhelmsson, Dahlgren, Hult, Scheja, Lonka, & Josephson, 2010). Providing undergraduate students with all the necessary tools to help them advance throughout their career is vital.

According to the National Center for Education Statistics, "undergraduate enrollment is projected to increase from 17.5 million to 19.6 million students between 2013 and 2024" ("Undergraduate Enrollment", 2015). With increasing enrollment,

universities have had to increase course enrollment and investigate new ways to instruct students. Traditionally, the classroom had been the standard when instructing students. However, due to enrollment increases and advances in technology, some courses have moved partially online (i.e., hybrid) or fully online in order to allow universities to increase course enrollment, as well as to create new courses (Porter, Pitterle, & Hayney, 2014). The traditional face-to-face lecture approach remains the prevailing method for teaching science at the postsecondary level, although there are a growing number of studies indicating that other instructional approaches are more effective (Deslauriers, Schelew, & Wieman, 2011).

Research that investigated lecture delivery method in relation to academic achievement, student engagement, performance, attitudes, and satisfaction has been completed. However, there is limited research correlating learning styles and lecture delivery method. Within the scope of the currently published research, multiple academic disciplines have been examined including mathematics, sociology, etc., yet there has been no research examining lecture delivery method in the undergraduate gross anatomy curriculum. As anatomy a very hands-on, concrete science, understanding the lecture delivery methods and their effectiveness for student achievement is imperative in developing new courses.

This particular study was conducted to investigate learning styles and lecture delivery method of undergraduate students enrolled in an undergraduate anatomy course. More specifically, this study examined the preferred learning styles of undergraduate gross anatomy students enrolled in a large enrollment gross anatomy course, the preferred

learning styles of these students reported by their majors/programs, the influence of gender on learning styles, the lecture delivery method of choice of students enrolled in a gross anatomy course during different curricular blocks (i.e., Back & Upper Limb, Head & Neck, and Thorax, Abdomen, & Pelvis), the influence of learning style on academic achievement, the influence of learning style on lecture delivery method of choice, the influence of lecture delivery method of choice on academic achievement, the influence of gender on lecture delivery method of choice for different curricular blocks, and the lecture delivery method of choice for the three largest majors/programs enrolled in the gross anatomy course.

Participating students were enrolled in Anatomy 2300 *Human Anatomy* during the spring of 2015 at The Ohio State University – Columbus Campus. The Index of Learning Styles (ILS) questionnaire developed by Drs. Richard Felder and Barbara Solomon, was completed by the participating students, along with a demographics survey. Participating students' highest ACT composite scores were obtained from The Office of Enrollment Services at The Ohio State University – Columbus Campus. The participating students' exam scores for Unit II – Back & Upper Limb, Unit III – Head & neck, and Unit IV – Thorax, Abdomen, & Pelvis, along with their declared lecture delivery method for Units II, III, and IV were also collected. A number of statistical analyses were performed on the data, including descriptive statistics, two-way contingency tables, multiple linear regression, and multinomial logistic regression, using SPSS Version 21 (IBM) for Windows.

Using the data obtained from the ILS questionnaire and demographic survey, along with the exam scores and declared lecture delivery method data, a number of results were found through statistical analyses. First, a general learning styles profile of all the students enrolled in Anatomy 2300 was constructed, along with learning styles profiles for students based on majors/programs. In regards to gender, there was no difference in three of the four learning style dimensions; however, there was a difference between the genders within the active/reflective dimension, a result which was not previously seen in the research (Litzinger *et al.,* 2005). It was also shown that learning style did not predict academic achievement, with the exception of the active/reflective (i.e., ACT/REF) dimension for Unit III – Head & Neck. Next, no statistically significant difference was found between the lecture delivery method of choice and Unit II – Back & Upper Limb, Unit III – Head & Neck, and Unit IV – Abdomen, Pelvis, & Thorax. It was found that the sensing/intuitive dimension was statistically significant in predicting lecture delivery method of choice in each unit. Next, in terms of the lecture delivery method of choice, only face-to-face was statistically significant for predicting academic achievement for Unit II and Unit III and there was no statistically significant difference found between gender and lecture delivery method. Finally, there was no statistically significant difference found between Pre-Medicine, Pre-Nursing, and Pre-Health Science students and their choice in lecture delivery method for each curricular unit.

This research project is the first to investigate learning styles and lecture delivery methods of undergraduate gross anatomy students. It aims to look at the uniqueness of Anatomy and to see how or if Anatomy is different from other STEM courses. This

research project was necessary to undertake for several reasons. First, in the broad scope of education, this study aims to provide relevant information for educators and administrators in order to better understand the needs of their students and to inform their development of more alternative teaching delivering tools for both on-campus and web-based instruction. Another reason for this research and study is more specific for the scope of undergraduate anatomy education. As anatomy is the language of medicine (Educational Affairs Committee, 1996, p. 99) and the majority of students who enroll in undergraduate anatomy courses plan on majoring in a health science related field and/or continuing in a professional school, it is imperative to understand the learning styles of students in such a class in an effort to improve the learning and retention during undergraduate education to best prepare these students for their future career goals. With the ever growing acceptance of students into universities and, thus, increasing class sizes, it is imperative to better understand students' lecture delivery choices and how these choices may impact student success in different areas of study. This research aims to better understand how these choices may impact students in an ever growing enrollment anatomy class. The major findings of this study are as follows:

- The learning styles of anatomy students indicated that these students have similar learning style preferences as students enrolled in other STEM courses. However, it appears that Pre-Medical and Pharmacy students are more reflective learners.
- It appears that the genders are similar in their preferred learning styles with the exception of the active/reflective dimension, with females more likely to be active learners, while males were more likely to be reflective learners.

- Academic achievement of anatomy students was only impacted by the active/reflective dimension within a complex, content-heavy unit (i.e., Head & Neck).
- Learning styles, particularly the sensing/intuitive dimension, appear to have some influence in choosing different lecture delivery methods within anatomy.
- In terms of lecture delivery method, anatomy students:
    - Showed a preference for the online only format.
    - With particular majors sometimes selected different lecture delivery methods, depending on topic.
    - Chose the same lecture delivery method independent of gender.
    - Who attended the face-to-face lectures scored higher on examinations.

Therefore, the information obtained from this research project serves to contribute to the theory of learning styles and its research base by adding additional knowledge within a new curricular area and student population. Additionally, this research provides instructors with a better understanding of their students as instructors work to modify and adapt their instruction for the diverse students they teach. A better knowledge and understanding of learning styles is becoming more critical as course sizes increase and as technological advances continue to change the options available to instructors. While research in this area continues to grow, faculty members should make great efforts to teach through multiple methods, those that both reach the greatest extent of students in a given class and challenge all students to further grow.

Chapter 2: Background

Learning Styles Defined

Students learn in many different ways. Just as no one person is the same in areas such as personality, preferences in music, etc., not one student learns and processes information the same way. Learning styles can be defined in different ways but as Keefe (1979) said, learning styles are "characteristic, cognitive, affective, and psychological behaviors that serve as relatively stable indicators of how learners perceive, interact with, and respond to the learning environment". When it comes to learning, some people prefer to work with more concrete and tangible information, such as facts and data, while others prefer to work more with abstract information, such as theories. Some individuals tend to use visual cues and presentations of information to learn, as opposed to others that prefer the verbalization of information to learn (Felder & Spurlin, 2005). Some people prefer to learn in small incremental steps, while others prefer to learn in large leaps (Felder & Spurlin, 2005). Each individual has a mix of learning styles and typically develops and assimilates what their dominant learning styles are through academic experiences (i.e., during schooling). Everyone responds to and needs input from all types of learning styles to some extent, but it's a matter of using what fits best with the given situation and a person's learning style preferences that allows the individual to succeed (Kolb, 1984).

Just as students' learning styles vary, so do the teaching methods. At the higher education level, some instructors prefer to utilize traditional lecturing, while others prefer to demonstrate and discuss information. Many instructors attempt to keep up with the technology and adapt to meet the evolving nature of their students. When teaching, some instructors prefer to focus on principles and applications, while other instructors strive for understanding and memorizing (Felder & Silverman, 1988). Sometimes this focus depends on the course, topic, and/or material being presented. As Felder and Spurlin (2005) stated in their article, *Applications, Reliability, and Validity of the Index of Learning Styles*:

> When the learning styles of most of the students in a class and the teaching style of the professor are seriously mismatched, the students are likely to become uncomfortable, bored and inattentive in class, do poorly on tests, get discouraged about the courses, the curriculum and themselves, and in some cases change to other curricula or drop out of school. (p. 103).

It is important for instructors to be aware of the collective learning styles of the students in their classes in order to promote student learning by orienting the course delivery according to the students' preferred methods. In order to better reach students and maintain their focus in the classroom, the course design/instruction should meet the needs of the students' learning styles (Felder & Brent, 2005). However, this becomes difficult with large enrollment courses where learning styles can vary greatly.

In order to categorize into different dimensions the ways in which people learn, learning styles instruments have been created. In a review by Hall and Moseley, the

authors reported there were at least 71 different learning style instruments available for use (Hall & Moseley, 2005). The concept of learning styles is credited to David Kolb, who published his model for a learning styles instrument in 1984 (Kolb, 1984). According to Kolb's Learning Style Inventory, there are four learning styles, namely diverging, converging, assimilating, and accommodating (Kolb & Kolb, 2005).

Learning styles instruments are have been utilized and investigated in various academic fields; however some of the primarily researched fields in which they have been utilized are engineering, mathematics, and the natural sciences (Felder & Spurlin, 2005). Some of the learning styles instruments used in science and engineering courses include the Myers-Briggs Type Indicator, Herrmann Brain Dominance Instrument, and the Felder-Silverman Model (Felder & Brant, 2005; Gravenhorst, 2007). While each learning style instrument has its own drawbacks, these tools are extremely useful in aiding instructors to learn more about the students they teach and aid the instructors in the development and application of useful teaching approaches (Breckler, Joun, & Ngo, 2009).

Learning Styles According to the Index of Learning Styles (ILS) Questionnaire

The Felder-Silverman Model, also known as the Index of Learning Styles (ILS), was published in 1988 by Richard Felder and Barbara Solomon. This instrument was developed to determine the learning style differences among engineering students and to aid instructors in an engineering program to design teaching approaches that would enable them to reach the learning needs of all their students (Felder & Spurlin, 2005). The ILS has been proven to be both reliable and valid (Felder & Spurlin, 2005; Litzinger,

Ha Lee, Wise, & Felder, 2007) in the engineering field and has also been used in a first-year undergraduate experimental anatomy course, aimed at teaching anatomy to dancing majors (Gravenhorst, 2007). The study found that the students were active, intuitive, visual, and sequential learners (Gravenhorst, 2007). The ILS utilizes some of the domains of the Meyers-Briggs Type Indicator, such as the sensing/intuition domain, and Kolb's Information Processing Model, such as the active/reflexive domain, and combines them (Gravenhorst, 2007). Through the ILS, students are classified as having a preference for four respective dimensions, specifically active/ reflective, sensing/intuitive, visual/verbal, and sequential/global. According to Felder & Silverman (1988), active learners learn by attempting and working with the content and prefer working with others, while reflective learners prefer working alone and sitting back and thinking things through before diving into the information. Sensing learners are concrete thinkers, as they are very practical and prefer to learn facts and mechanisms, while intuitive learners are more abstract in their thinking and prefer to learn concepts and implicit significance. Visual learners prefer visual representations of materials (e.g., figures, graphs, charts, etc.), while verbal learners prefer written text and spoken explanation. Sequential learners are very linear in their thought process and tend to put information together to learn in small incremental steps, while global learners are more integrated in their thinking process and put information together to learn in larger leaps (Felder & Spurlin, 2005).

Each one of these dimensions is demonstrated in the anatomy laboratory can be addressed through different course organization and displayed by students by their

different study habits. For example, active students in an anatomy course would prefer to learn material by working hands-on with models, bones, cadavers, etc., while reflective learners would rather be hands-off and not rely on those resources. Sensing learners in anatomy would use clinical applications to understand the concrete material to see how it fits in the real world, while intuitive learners would prefer to be provided with interpretations of information. Visual learners in anatomy would prefer to use cadavers, atlases, muscle charts, etc., while verbal learners would prefer straight text to describe structures. Sequential learners in anatomy would prefer to be presented information in a step-wise fashion in order to see how the big picture works together, such as learning regional anatomy piece-by-piece, while global learners would prefer to start with the big picture, such as all the organ systems working together, in order master the details of each system.

Learning Styles in the Health Sciences

One of the most considerable and compelling problems that educators face is improving the level of student satisfaction in regards to courses and the learning environment of the classroom (Murphy, Gray, Straja, & Bogert, 2004). At many large postsecondary institutions, an ever increasing university enrollment rate has led to an increase in the offerings of large enrollment courses. When teaching in such a large environment and to such a diverse student population, one of the most successful strategies for teaching is to present the information using multiple learning styles (Dobson, 2009). It has been shown that when instructors present information using students' preferred learning styles, the instructors are able to connect with their students

and enable these students to learn more effectively (Alkhasawneh, Mrayyan, Docherty, Alashram, & Yousef, 2008; Laight, 2004; Meechan-Andrews, 2009; Miller, 1998).

Because anatomy (i.e., the study of the architecture of the human body) is at the core of the health professions (Wright, 2012), there has been a considerable amount of research on its instruction in professional programs, such as medical and dental, and how learning style preference can influence students' achievement. However, there is much less research investigating the learning styles of undergraduate (i.e., pre-baccalaureate) gross anatomy students. Since a number of undergraduate students are interested in health science careers, it is imperative to look at the learning styles they utilize. Focusing on the quality of undergraduate anatomical education is vital to students preparing for a career or transitioning into areas such as professional or graduate school (Wehrwein, Lujan, & DiCarlo, 2007). When these students matriculate to their intended career or professional program, there is often a presumption that they have a gained a set of knowledge and skills during their undergraduate education. In fact, many programs historically have or are now beginning to require anatomy for matriculation into their programs. Additionally, undergraduate students who may go on to more advanced undergraduate anatomy courses during their tenure as an undergraduate are also presumed to have a base of learned material they were to have acquired during the more introductory levels of anatomy. Hence, there is a necessary need to improve "learning and retention during undergraduate education to ensure that students are prepared to handle the challenges that they will face both in future courses and after graduation" (Wehrwein, Lujan, & DiCarlo, 2007). Much of the research has been focused on learning

style preferences of undergraduate physiology students (Breckler, Joun, & Ngo, 2009; Dobson, 2009; Wehrwein, Lujan, & DiCarlo, 2007), with a noticeable lack of research on the learning style preferences of students enrolled in undergraduate gross anatomy courses.

Learning Styles and Gender

One of the big questions in education is whether or not there are specific differences between males and females in terms of learning. In regards to learning styles, there is evidence of differences in learning styles based on gender, which appear to be socially constructed and specifically associated with the science, math, engineering, and technology (SMET) fields (Milgram, 2009). In education, whether or not males and females learn differently and/or have a particular preferred way of learning is a topic which can present many different implications in instruction (Wehr, Lujan, & DiCarlo, 2007). Most research on this topic has suggested that the preferred learning styles of males and females is primarily equally distributed in most learning dimensions. However, there seems to be a slight difference when it comes to the abstract/concrete dimension of learning, with females being more concrete learners and males being more abstract learners (Kulturel-Konak, D'Allegro, & Dickinson, 2011). With this previous research completed, the next area of research is the examination of whether or not a specific gender has a preferred learning style within a given field of study, as this information can aid in the development of effective teaching approaches (Wehrwin, Lujan, & DiCarlo, 2007).

In a study by Wehrwin, Lujan, & DiCarlo (2007), undergraduate physiology students were surveyed to determine if there was differences in learning styles using the VARK (i.e., Visual, Auditory, Reading/Writing, Kinesthetic), which is another type of learning styles instrument. The researchers found that males preferred multiple modes of presentation, while females primarily preferred to learn with one mode. Additionally, they found that males were able to adjust to different teaching methods and utilize all their learning styles, while females relied strongly on one teaching method and preferred to not have that method altered as they only utilized one dominant learning style for the course.

Methods of Instruction & the Rise of Online Learning

The field of education is constantly changing with advances in technology and new research findings in order to reach all students and provide them with the best access to knowledge. Education tends to be at the forefront of utilizing many new educational technologies and for setting aside large resources for developing new technologies to improve teaching and learning (Vinu, Sherimon, & Krishnan, 2011). With the surge of technological advances and the ever growing enrollment rate at community and four-year institutions, the process of communicating with students in an educational setting is constantly changing and accommodating (Allen, Mabry, Mattrey, Bourhis, Titsworth, & Burrell, 2004).

The long-standing primary method of teaching has been face-to-face instruction. The traditional term for this type of instruction is the didactic method, in which an instructor delivers factual information to students and where the students passively

receive this information. Hence, this type of instruction is primarily teacher-centered. These face-to-face interactions have been successful, as they provide the students with the invaluable opportunity to interact with the instructor and, at a lesser level, fellow classmates. However, this traditional method has some limitations/disadvantages that vary depending on the institution, including the lack of efficient classroom equipment (e.g., lack of smartboards and lack of projectors), accessibility of the instructional institution for students (especially for students such as commuters), and the limitation of classrooms in both total number available and total capacity (Vinu, Sherimon, & Krishnan, 2011). For many large and growing institutions, high enrollment has led to very large class sizes which lead to the issue of where to teach these large traditional face-to-face courses, as the number of large capacity classroom is limited or even null (Euzent, Martin, Moskal, & Moskal, 2011). Additionally, very large class sizes tend to limit actual student interaction with the instructor during instruction/class time.

There is a trend in most universities to teach students in the same way throughout all their courses, which tends to be in a straight forward didactic lecture format. The high use of this format by educators is because of its ease for passing on the vast amount of information content that needs to be covered, a program's long history of traditional lecturing, and/or even reflects an instructor's own preference in learning (Wehrwein, Lujan, & DiCarlo, 2007).

Online learning developed from the workings of distance education (Kruger-Ross & Waters, 2013). Holmberg (1986) defined that distance education involves "various forms of study at all levels which are not under the continuous, immediate supervision of

tutors present with their students in lecture rooms or on the same premises, but which, nevertheless, benefit from the planning, guidance, and tuition of tutorial organization" (p. 26). Through this idea, structured online learning began more as an asynchronous activity, which included, but was not limited to, posting on discussion boards (Vrasidas & Stock-McIssac, 1999) and to the uploading of course assignments. There are many working definitions of online learning, but the simplest or most straight-forward definition was developed by Larreamendy-Joerns & Leinhardt (2006) who stated that online learning is, "instruction through a connection to a computer system at a venue distant from the learner's personal computer" (p. 568).

Online courses are beneficial because they can reach a much larger and more diverse student population. Students can live further from campus, as they do not need to be living physically near the institution where the course is being offered. Online courses also help institutions where overcrowding is an issue and can allow for more classes to be offered during peak times (Brown, 2012). In multiple research articles, authors surveyed students who had taken online courses and asked these students the top reasons why they registered for online classes. The top answers provided by students were flexibility, convenience, greater control over course material, eliminating scheduling conflicts, and more control over the pace of the class (Brown, 2012; Rabe-Hemp, Woollen, & Humiston, 2009; Wuensch, Aziz, Ozan, Kishore, & Tabrizi, 2008). In terms of wanting to meet the needs of their students, more online courses are now being offered and some programs are offering fully online degrees. In the report, *Changing Course: Ten Years of Tracking Online Education in the United States*, the authors, along with The Babson

Survey Research Group, found that the number of students taking at least one online course rose from 572,000 in the fall of 2010 to 6.7 million students in the fall of 2011, with 32% of all postsecondary students taking at least one online course (Allen & Seaman, 2013).

In higher education, teaching in a laboratory/lecture (i.e., teaching in a lecture hall/classroom a few times a week and also having a laboratory component once or twice a week format is common for many STEM courses (Perkins, 2005). Many of the undergraduate anatomy (as well as the combined anatomy & physiology) courses utilize this framework, including the Anatomy 2300 course offered at The Ohio State University - Columbus Campus offered by the Division of Anatomy in the College of Medicine. These courses often consist of one lecturer providing the lecture in a single, large lecture hall multiple times a week and are complemented by multiple, smaller-group labs, often taught by adjunct faculty, graduate students, or undergraduate students. Large group lectures tend to lack multiple opportunities for instructor-student interaction (Beck & Ferdig, 2008). Changing from the traditional lecture delivery method of face-to-face instruction to online methods of teaching can often produce "extraordinary modifications in the perceptions of teachers" (Dringus, 2000).

The Value of Undergraduate Gross Anatomy

"Anatomy is the language of medicine because all of medicine relates to the human body and the function of its various parts and systems" (Beahrs, 1991, p. 310). As stated previously, human anatomy is at the core of the health professions by educating students about the intricacies of the human body (Wright, 2012). The information taught

in gross anatomy is the foundation upon which all health professionals build their knowledge. Traditionally, undergraduate (as well as medical) gross anatomy courses mainly consisted of face-to-face lectures which were complemented with laboratory sessions involving cadaveric dissection (Drake, Lowrie, & Prewitt, 2002; Minhas, Ghosh, & Swanzy, 2012; Sugand, Abrahams, & Khurana, 2010; Wright, 2012). This format is still common amongst medical school anatomy courses.

In recent years, there has been a drive to utilize a wider variety of pedagogical methods in medical school, as well as in some undergraduate courses, including anatomy. Many courses implement the learner-centered approach where students work in small groups during lecture enabling a much more individualized learning environment (Minhas *et al*., 2012; Prince, Van Mameren, Hylkema, Drukker, Scherpbier, & Van Der Vleuten, 2003). At some institutions, dissection has been replaced with 3-D imaging, plastic models, and computer or web-based programs (Drake *et al.,* 2002; Minhas *et al*., 2012; Sugand *et al*., 2010; Wright, 2012). Another change in recent years has been a drastic decrease in the number of hours medical students spend in their anatomy courses (Drake *et al*., 2002; Drake, McBride, Lachman, & Pawlina, 2009).

When it comes to professional/graduate and undergraduate anatomy courses, both course design and pedagogical issues tend to be fairly similar between the academic levels, although there are some differences that instructors need to consider. There is typically a lecture and laboratory component in both levels of courses, but cadaveric dissection is rare in undergraduate courses. Fortunately, at The Ohio State University – Columbus Campus, the undergraduate anatomy courses offered by the Division of

Anatomy does utilize prosected cadavers for teaching. Factors such as cost, availability of donors, or proper facilities make it challenging for most undergraduate courses to included dissection as part of their laboratory component (Wright, 2012). Therefore, undergraduate anatomy students typically study from plastic models, textbooks, and/or computer-based programs. Additionally, the student population in undergraduate courses is much more diverse than in medical gross anatomy in regards to student interests and career goals (Collier, Dunham, Braun, & O'Loughlin, 2012; Husmann, O'Loughlin, & Braun, 2009; Minhas *et al*., 2012; O'Loughlin, 2002) and, finally, time (i.e., only a quarter or semester) is a limiting factor for how much depth material can be covered in undergraduate courses.

Many health professional schools require an anatomy prerequisite for matriculation in their respective programs and majors. Recently, The Ohio State University College of Medicine implemented an anatomy prerequisite requirement for matriculation into its medical curriculum. Academic success in anatomy (as well as physiology) is crucial for undergraduate students interested in health care professions. Additionally, acceptance into undergraduate health care professional programs is partly dependent on successful student performance in these courses.

Students must develop an adequate understanding of the structures of the body in order to succeed in their chosen field. Although there is an increase in the requirement of an undergraduate anatomy course for matriculation into many graduate and professional programs, undergraduate students are still faced with fewer undergraduate institutions offering such a course (Wright, 2012). The lack of effective undergraduate anatomy

courses is due in part to expenses involved with administering the course, logistical issues, a lack of appropriately trained anatomy faculty, and the increasing enrollment totals (Darda, 2010; Wright, 2012). As more and more programs begin to include gross anatomy as a prerequisite, it is important to increase the availability of such courses.

Research Questions and Hypotheses

This current study was conducted to address the following questions and to allow the testing of several hypotheses about learning styles and the lecture delivery method for undergraduate students enrolled in a gross anatomy course.

Question 1: What is the predominant learning style of students in an undergraduate gross anatomy course? It is hypothesized that the preferred learning styles of the students in the course will be active, sensing, visual, and sequential learners.

As there is no current research utilizing the ILS questionnaire within an undergraduate anatomy course, this hypothesis was developed from research utilizing the ILS questionnaire in different fields of study. In these areas, including different engineering specialties, the results of the ILS questionnaire indicated that the preferred learning styles were the active, sensing, visual, and sequential dimensions (Felder & Spurlin, 2005). The hypothesis was also developed through various studies which utilized the VARK learning style instrument. These studies were conducted in a physiology course, which is closely aligned with anatomy due to the Principle of Complementarity of Structure and Function (i.e., 'function always reflects structure'). In regards to the VARK results from the study by Dobson (2009) looking at undergraduate physiology students, the primary sensory modality found was the visual modality, with

the read/write (i.e. verbal) modality second. Interestingly, the kinesthetic modality was the least preferred sensory modality.

Question 2: What is the predominant learning style of students within particular majors/programs that are registered for an undergraduate gross anatomy course? It is hypothesized that the predominant learning styles of different majors/programs will vary.

Through authentic interactions (e.g. student interactions through office hours, emails, laboratory sessions, etc.) with previous students in Anatomy 2300, it appears that there is variability in the learning styles of students in different majors/programs. Unfortunately, research is limited within the scope of specific learning styles of students and their future career choice. A 2009 study by Brown *et al.* looked at the learning style preferences of health science major students, including occupational therapy, physiotherapy, paramedics, social work, nutrition & dietetics, pharmacy, radiation therapy, radiography, nursing, and midwifery. The results of their study indicated the preferred learning styles of the group as a whole and did not take into account each individual major. Another study used to construct this hypothesis included a study by Breckler, Joun, and Ngo (2008) who utilized the VARK learning style instrument and only focused on whether or not students possessed unimodal or multimodal learning styles and how this was correlated with their future career choice. These researchers found that more than half of the pre-health professional students in their study had multiple learning preferences. When they looked at the variation in career aspiration of these pre-health professional students they found that premedical students were similar to first-year medical students in that both had large numbers of multimodal learning

preferences, while students interested in dentistry also were similar to first-year dental students in that both groups had smaller numbers of multimodal learning preferences (Breckler *et al.,* 2008).

Question 3: Are there gender differences in preferred learning styles in an undergraduate gross anatomy course? Based on previous research, it is hypothesized that there will be no gender differences for preferred learning styles except in the sensing/intuitive dimension.

Previous research utilizing the VARK has indicated that there is no significant difference between the different sensory modalities and gender (Dobson, 2009; Wehrwein, Lujan, & DiCarlo, 2007). However, Dobson (2009) indicated that there was an difference in the aural (i.e., hearing) modality, with females preferring the aural modality more than males. These studies focused primarily on the number of modalities males and females preferred. In a study, in which the ILS was utilized, gender differences were seen in all the dimensions, except for the active/reflective dimension (Litzinger, Lee, Wise, & Felder, 2005).

Question 4: Is there a difference in lecture delivery method between the three units of information for the Anatomy 2300 course? It is hypothesized that there will be a difference in lecture delivery method of choice between the three different Units (i.e. Unit II – Back & Upper Limb, Unit III – Head & Neck, and Unit IV – Thorax, Abdomen, & Pelvis), due to the informational and content differences in each of the units.

Research is limited within the scope of lecture delivery method of choice between different units or sections in a course. Previous research has only focused on which

lecture delivery method students preferred for an entire semester, not for individual content units. These previous studies have looked at traditional (i.e. face-to-face), online, and blended lecture delivery. For example, research has focused on comparing student engagement, performance, attitudes, and satisfaction within the different lecture delivery methods (i.e. online, face-to-face, and blended).

Question 5: Does a student's preferred learning style predict academic achievement per respective unit (i.e., Unit II, Unit III, and Unit IV) within an undergraduate gross anatomy course, when controlling for academic ability? It is hypothesized that when controlling for academic ability, learning style will impact academic achievement in an undergraduate gross anatomy course. Specifically, academic achievement will be impacted in Unit II and Unit III as these two units, historically, has been the toughest for students.

As there is no research with the ILS questionnaire in an undergraduate anatomy course, these hypotheses were developed from research utilizing the VARK. Previous research has indicated that there was a significant relationship between sensory modalities and course performance (Dobson, 2009). This research focused on one lecture exam of the course, one lab exam of the course, and the overall course grade. Unfortunately, there is no research examining different exams scores throughout the course.

Question 6: Does a student's preferred learning style predict their lecture delivery method in an undergraduate gross anatomy course for each respective unit (i.e., Unit II, Unit III, and Unit IV)? It is hypothesized that learning styles predicts lecture

delivery method in an undergraduate gross anatomy course per respective unit. Specifically, lecture delivery method will be strongly predicted by the dimensions active/reflective and visual/verbal, but not in the dimensions of sensing/intuitive and sequential/global.

Currently, research is absent within the scope of learning styles and lecture delivery method. Through authentic interactions with previous students in Anatomy 2300, it appears that there are some learning style dimensions, such as the active/reflective and visual/verbal dimensions, which will predict lecture delivery method of students.

Question 7: Does lecture delivery method predict academic achievement on respective unit (i.e., Unit II, Unit III, and Unit IV) assessments in an undergraduate gross anatomy course, when controlling for academic ability? It is hypothesized that the three different methods of lecture delivery will predict academic achievement in two of the three units (Unit II and Unit III) as these two units are vastly different in content and students have noted they changed lecture delivery methods from Unit II to Unit III.

Studies have indicated that there is a slight difference between different lecture delivery methods and performance in a class (i.e., scores on exams and end grade in the course). Some research has indicated that math students in a blended environment do not perform as well as their counterparts in online and face-to-face courses on exams covering different mathematical concepts (Ashby, Sadera, & McNary, 2001). However, studies of students in economics courses have shown that there is no difference in lecture delivery method and course achievement (Coates, Humphreys, Kane, & Vachris, 2004).

To date there is no research focused on large enrollment anatomy courses. However, through authentic interactions (e.g. student interactions through office hours, emails, laboratory sessions, etc.) with previous students in Anatomy 2300, it appears that there is a difference between the different lecture delivery methods and academic achievement, with those students choosing the face-to-face method performing higher on exams than those students who choose either the online method or the blended method.

Question 8: Is there a gender difference in lecture delivery method per respective unit (i.e., Unit II, Unit III, and Unit IV) in an undergraduate gross anatomy course? It is hypothesized that there will be a gender difference in lecture delivery method of choice across all three units in the Anatomy 2300 course.

Previous research in different academic fields, such as engineering, economics, and math, have indicated that there is no gender difference in lecture delivery method of choice. However, through previous observations within earlier Anatomy 2300 courses, more males have indicated they prefer primarily online lectures in comparison to females who have indicated they prefer the traditional lectures.

Question 9: Do students in the three largest majors/programs have a difference in lecture delivery method of choice per respective unit? It is hypothesized that there will be a difference between the three largest majors and their lecture delivery method of choice for each unit. This research will look at if there are differences in lecture delivery method of students between the different majors/programs.

No previous studies have looked at lecture delivery method and students enrolled in different majors/programs. Therefore, this hypothesis was developed due to previous

observations within the Anatomy 2300 course, which indicated that specific majors seemed to prefer particular lecture delivery methods.

Significance for Study

This research project was necessary to undertake for several reasons. First, in the broad scope of education, this study aims to provide relevant information for educators and administrators in order to better understand the needs of their students and to inform their development of more alternative teaching delivering tools for both on-campus and web-based instruction. Once the preferred learning styles of students are defined, educators may better engage these students, as well as work in and with their universities to meet the demands of the growing distance education, online learning populations, and traditional face-to-face lectures. The hope is to increase the level of student satisfaction with their education, as well as to promote a better program "fit" for students and capitalize on learning opportunities in the courses.

Another reason for this research and study is more specific for the scope of undergraduate anatomy education. As anatomy is the language of medicine (Educational Affairs Committee, 1996, p. 99) and the majority of students who enroll in undergraduate anatomy courses plan on majoring in a health science related field and/or continuing in a professional school, it is imperative to understand the learning styles of students in such a class in an effort to improve the learning and retention during undergraduate education to best prepare these students for their future career goals. Besides aiding students' understanding of their learning styles, this research also aims to inform instructors to help them adapt their teaching methods to reach all different learning style preferences of

students. With the ever growing acceptance of students into universities and, thus, increasing class sizes, it is imperative to better understand students' lecture delivery choices and how these choices may impact student success in different areas of study. This research aims to better understand how these choices may impact students in an ever growing enrollment anatomy class. Additionally, this research aims to provide evidence on the value of the creation of new online courses, as well as and the maintenance of traditional face-to-face courses, which may be appropriate for a particular subset of students.

Chapter 3: Methods

Student Participation in Study and Recruitment

Students were enrolled in one of four sections of Anatomy 2300 – *Human Anatomy* during the spring 2015 semester at The Ohio State University – Columbus Campus were given the opportunity to participate in the study. Most students enrolled in Anatomy 2300 are required to complete this course to enter their undergraduate major/program (e.g. Nursing, Athletic Training, Exercise Science, etc.), once accepted into their program (e.g. Health Sciences, Radiologic Sciences, etc.), or as pre-requisites into graduate or professional programs (e.g. Medical School, Dental School, Physical Therapy, Occupational Therapy, Physician Assistant, etc.). Student demographics, including gender, age, ethnicity, class section of Anatomy 2300, academic year, credit hours completed at the beginning of the spring 2015 semester, major, intended career plan, and whether or not a participant was an international student or a domestic student were collected as part of this study.

Participants were initially recruited for the study during the first laboratory session for Unit II (either Wednesday, February 11, 2015 or Monday, February 16, 2015). Participants were informed of the study, the consent form, as well as the potential incentives of the study which included being entered into a raffle to win one of eight $25.00 Amazon gift-cards. Individuals who were not present for the initial recruitment

process were recruited during the second laboratory session (either Wednesday, February 17, 2015 or Monday, February 23, 2015) or were able to meet with the researcher outside of class hours (Appendix A & B).

Anatomy 2300 – Human Anatomy Course and Assessments

Anatomy 2300 or *Human Anatomy* is a large enrollment undergraduate anatomy course offered at The Ohio State University-Columbus Campus through the Division of Anatomy in the College of Medicine. It is a four credit hour course offered during autumn, spring, and summer semesters. Anatomy 2300 is divided into four sections (i.e., 2300.01, 2300.02, 2300.03, and 2300.04) for registration purposes only in order to provide the necessary number of reserved seats for different programs. Anatomy 2300.01 is an open enrollment section in which students in different programs in the School of Arts and Sciences, as well as Continuing Education students, can register. Anatomy 2300.02 is reserved for Pre-Dental Hygiene students, 2300.03 is reserved for Pre-Nursing students, and 2300.04 is reserved for Health and Rehabilitation Sciences (HRS) students (e.g. Pre-Physical Therapy, Pre-Occupational Therapy, Pre-Health Sciences, Pre-Radiologic Sciences etc.), as well as Pre-Dentistry, Pre-Optometry, Pre-Exercise Science, and Pre-Pharmacy.

The class consists of a lecture component, which is available to students as a traditional face-to-face lecture held three days a week for 55 minutes, and as online lectures, recorded during a previous offering (i.e., Winter 2012), which students can readily access as downloadable audio (i.e., .mp3) and streaming videos. All the lectures (i.e., traditional and online) cover the exact same material with the exact same

PowerPoint slides. The in-person lectures are presented by a graduate teaching associate, while the previously captured lectures were presented by an assistant professor in the Division of Anatomy. Both individuals collaborate to construct the course assessments. Students can choose their lecture delivery method (i.e., attending the traditional face-to-face lectures, viewing and/or listening to the online lectures, and/or a mixture of both), but they are required to attend all laboratory sessions. The laboratory sessions (each having a maximum of 64 students) are held once a week for approximately two-hours and are authentic hands-on laboratory experiences where students are taught using primarily prosected cadavers along with plastic bone casts, models, and x-rays.

Anatomy 2300 is divided into four units of content. Unit I covers introductory material, as well as the lower limb. Unit II covers the back and the upper limb. Unit III covers the head and neck, including the brain and spinal cord. Finally, Unit IV covers the abdomen, pelvis, and thorax. In terms of length of time, Unit II is the shortest (i.e., approximately two weeks), while the other three units are relatively similar in length (i.e., approximately three weeks).

At the end of each unit, students complete a 100-point exam consisting of 50 multiple-choice and matching questions. The assessment questions are primarily text-based with a few image-based. All students in the course, regardless of their lecture delivery choice, take the same end of unit examination in a large lecture hall as both the instructors collaborate to construct course assessments.

The course also includes online quizzes which supplement each lecture within each unit. Students are required to take these quizzes in sequence with the lectures as

many times as they need to receive 100%. Once a student receives 100%, the next quiz in the sequence opens. However, when a student receives 100% on the last lecture quiz within a unit, a Master Quiz opens which is worth ten points of the student's total points for the semester. A student has unlimited attempts to successfully complete this Master Quiz before a close date, which is a few days before the unit exam. All quizzes are multiple-choice and composed of text-based questions, with the exception of the Master Quizzes which, although still multiple-choice, are all image-based questions.

Administration of the Index of Learning Styles (ILS) Questionnaire and Demographics Survey

The Index of Learning Styles (ILS) questionnaire (Appendix C) and a short demographics survey (Appendix D) were administered to Anatomy 2300 students who consented to participate in the study during the first laboratory sessions of Unit II. Students who consented to the study filled-out the questionnaire and survey during the first 20 minutes of their respective laboratory time. The ILS questionnaire was scored following student completion and the results of the survey were provided to participants one week later during the second laboratory session of Unit II (Appendix E). Students also received study tips to consider based on their calculated learning style (Appendix F). Students not present for the initial administration were also given the opportunity to fill-out the ILS questionnaire during the second laboratory session of Unit II or outside of class time if they chose. Students who did not consent to the study were also given the opportunity to fill-out the ILS questionnaire and received their individualized results without their data being utilized for the study.

Creating the Database

A large excel database was constructed by a graduate student in the Division of Anatomy who was involved in the study strictly in this capacity. This database initially included all the following information from consented participants: names (first and last), demographic information (including gender, age, ethnicity, class section of Anatomy 2300, academic year, credit hours completed at the beginning of the spring 2015 semester, major, intended career plan, and whether or not a participant was an international student or a domestic student), highest ACT composite score or highest SAT score (obtained from the Office of Enrollment Services at The Ohio State University-Columbus Campus), results of the ILS questionnaire for each of the four dimensions of learning styles (i.e. active/reflective, sensing/intuitive, visual/verbal, and sequential/global), examination scores for Unit II, III, and IV (obtained from the course director), and reported lecture delivery method for Unit II, III, and IV (obtained from the course director). Before any statistical analyses were conducted on the data, the database was de-identified to ensure that the data was rendered anonymous. Once all data was entered into the database and cleaned, it was transferred to SPSS Statistics Version 21 for Windows for statistical analyses.

Cleaning of Data

Once the database was created, data had to be cleaned in order to conduct analyses. Certain participant data were automatically removed from the entire study if they did not consent for their information to be used in the study during the recruitment process.

Other participant data were dropped from individual analyses based on certain criteria: did not fill-out the ILS questionnaire, did not answer questions in the demographics survey, did not report their lecture delivery method for a particular unit, did not have a reported highest ACT composite score from the Office of Enrollment Services at The Ohio State University-Columbus Campus or have a reported highest ACT composite score of "0" reported, and/or did not complete a unit examination (i.e., dropped the course). These criteria will be further discussed in the description of each analysis conducted.

Some majors were combined as there were multiple spellings, misspellings, alternate names for the same major/program, etc. reported by participants.

Demographics of Participants

Demographic data on student participants were obtained through a short survey (Appendix D). After participants were removed based on the automatic criteria listed above, descriptive statistical analyses were conducted to provide demographic characteristics of the sample population in the areas of gender, age, ethnicity, class section of Anatomy 2300, academic year, credit hours completed at the beginning of the spring 2015 semester, major, intended career plan, and whether or not a participant was an international student or a domestic student. Age of the undergraduate participant was calculated as of February 23, 2015.

Scoring of the Index of Learning Styles (ILS) Questionnaire

Every student was initially scored as per the usual continuum scoring of the ILS questionnaire (Appendix G). Although students received their individual ILS scores as a

continuum, for data analysis a modification to scoring was utilized. The researcher took the study's research questions and analyses and implemented an either/or scale, meaning that no matter where a student participant fell on a continuum the researcher used the letter (representing the dimension) for each student. For example, if a student scored a 3A for the active/reflective (i.e., ACT/REF) dimension, the researcher scored the participant as the letter A (i.e., active).

After student participants completed the ILS questionnaire, the questions were scored. The results of each of the four dimensions for each student were entered into the excel database as dichotomous categories with either a "1" indicating one side of a dimension (i.e., active, sensing, visual, or sequential) or "0" indicating the opposite side of a dimension (i.e., reflective, intuitive, verbal, or global).

Student's Primary Lecture Delivery Method

A survey question to determine a student's primary lecture delivery method of choice was completed by participants at the end of Unit II's, Unit III's, and Unit IV's examinations. This question was presented/asked on the course examinations and utilized for course development and internal reporting purposes in the Division of Anatomy. At the beginning of all unit examinations an announcement was made in order to remind students who had consented to the study to be sure to fill-out the question at the end of their Scantron form. This data was coded and entered into the Excel database as listed: 1 = face-to-face only; 2 = online only; 3 = mixture of both. If a participant did not report their lecture delivery method of choice or the participant did not take the examination, they were dropped from statistical analysis for a particular unit.

American College Test (ACT)/Scholastic Aptitude Test (SAT) Scores

A formal request was written to the staff at the Office of Enrollment Services at The Ohio State University-Columbus Campus to obtain the ACT/SAT score (plus the standardized scores, if available) for each individual student enrolled in the four sections of Anatomy 2300 – *Human Anatomy* during the Spring 2015 Semester at The Ohio State University – Columbus Campus. This information was provided in an encrypted Microsoft® Excel spreadsheet and entered into the study. Upon review of this data, it was determined to utilize the highest ACT composite score as all participants had highest ACT composite scores and not all had SAT scores. All students had highest ACT composite scores reported as the Office of Enrollment Services at The Ohio State University-Columbus Campus transformed the SAT scores of students into ACT scores and only the highest composite scores were reported.

Analyses to Address Research Questions

With the data cleaned, the following analyses were conducted to address each of the following research questions. For each of the analyses, significance was set at $p \leq 0.05$, unless otherwise specified.

Question 1: What is the predominant learning style of students in an undergraduate gross anatomy course? In order to investigate the predominant learning styles of students enrolled in Anatomy 2300, regardless of academic year, gender, age, and major/program, the ILS questionnaire data was used. Descriptive statistics were conducted in SPSS to determine the predominate learning styles of the class as a whole on each dimension.

Question 2: What is the predominant learning style of students within particular majors/programs that are registered for an undergraduate gross anatomy course? In order to determine the predominant learning style of students within particular majors/programs enrolled in Anatomy 2300, regardless of their gender, academic year, and age, the ILS questionnaire data, along with student's declared major/program, was used. Descriptive statistics were conducted in SPSS to determine all the different majors/programs enrolled in the course. All majors/programs were analyzed except if a major/program had only one student enrolled in the course. Once all majors/programs were determined, descriptive statistics were conducted for each major/program on each of the four dimensions of learning styles.

Question 3: Are there gender differences in preferred learning styles in an undergraduate gross anatomy course? In order to investigate whether there were gender differences in preferred learning styles, four two-way contingency tables were created in SPSS, with the rows representing gender (i.e., male or female) and the columns representing preferred learning styles in the four dimensions (i.e., active/reflective, sensing/intuitive, visual/verbal, and sequential/global). Four individual two-way contingency tables were constructed. In order to create these contingency tables, descriptive statistics were initially conducted to determine the number of males and/or females who scored into each of the different sub-dimensions (i.e., males reported as active learners versus males reported as reflective learners). With the frequencies the contingency tables were created and were analyzed using Crosstabs in SPSS. A p-value

of 0.0125 was set in order to spread the overall study significance (i.e., 0.05) through the four dimensions of the instrument to control for Type I error.

Question 4: Is there a difference in preferred lecture delivery method between the three respective units? In order to determine if there was a difference in preferred lecture delivery method per unit (i.e. Unit II, Unit III, and Unit IV), a two-way contingency table was created, with the rows representing reported lecture delivery method of choice (i.e., traditional, online, or a mixture of both) and the columns representing the three curricular units. If a significant ($p \leq 0.05$) difference was found with the initial analysis, then follow-up pairwise comparisons were conducted in order to evaluate the differences among the proportions. If follow-up pairwise comparisons were made, a Holm's sequential Bonferroni correction method was used at the initial $p \leq 0.05$ level across all comparisons to control for Type I error.

Question 5: Does a student's preferred learning style predict academic achievement per respective unit within an undergraduate gross anatomy course, when controlling for academic ability? To investigate a possible relationship between a student's preferred learning style and academic achievement at each of the three end of unit examinations, multiple linear regression analyses were conducted. During these analyses, academic ability was controlled using the highest ACT composite score. For this question, subjects were removed from the analysis if there was no highest ACT composite score reported or if there was a highest ACT composite score of "0" reported. A participant was also dropped from the analysis if they dropped the course and did not

complete the unit examination for the particular unit being analyzed. The equation being investigated is:

$$\text{Unit exam score} = b_0 + b_1\text{ACT/SAT} + b_2\text{ACT/REF} + b_3\text{SEN/INT} + b_4\text{VIS/VER} + b_5\text{SEQ/GLO} + e$$

Question 6: Does a student's preferred learning style predict their lecture delivery method in an undergraduate gross anatomy course for each respective unit? In order to determine if a student's preferred learning style predicts their reported lecture delivery method a multinomial logistic regression was conducted on the data. Multinomial logistic regression was used because the dependent variable (i.e. lecture delivery method) was categorical with more than two categories (i.e. face-to-face, online, or a mixture of both).

Question 7: Does lecture delivery method predict academic achievement on respective unit assessments in an undergraduate gross anatomy course when controlling for academic ability? In order to investigate a possible relationship between a student's reported lecture delivery method and academic achievement at each of the three end of unit exams, multiple linear regression analyses were conducted. These analyses utilized dummy coding as lecture delivery method is a categorical variable with more than two levels (i.e., face-to-face only, online only, or a mixture of both). Recoding the categorical variable (i.e., lecture delivery method) into a number of separate, dichotomous variables permitted the analyses to be interpretable. During these analyses, academic ability was controlled using the highest ACT composite scores. A participant's data was not used for these analyses if there was no reported highest ACT composite score or if there was a

highest ACT composite score of "0" reported. A participant was also removed from these analyses if they did not complete the unit exam for the unit being analyzed. The equation being investigated is:

Unit exam score = b_0 + b_1ACT/SAT + b_2Face-to-Face + b_3Online + b_4Mixture + e

Question 8: Is there a gender difference in lecture delivery method per respective unit in an undergraduate gross anatomy course? In order to investigate whether there were gender differences in lecture delivery method per respective unit, a two-way contingency table was constructed for each unit, with the rows representing gender (i.e., male or female) and the columns representing reported lecture delivery method of choice (i.e., face-to-face, online, and/or mixture of both). If a significant ($p \leq 0.05$) difference was found with the initial analysis, then follow-up pairwise comparisons were conducted in order to evaluate the differences among the proportions. If follow-up pairwise comparisons were made, a Holm's sequential Bonferroni correction method was used at the initial $p \leq 0.05$ level across all comparisons to control for Type I error.

Question 9: Do students in the three largest majors/programs have a difference in lecture delivery method per respective unit? In order to investigate whether there were major/program differences in lecture delivery method per respective unit, two-way contingency tables were constructed for each unit, with the rows representing major/program (i.e., Pre-Nursing, Pre-Medicine, & Pre-Health Science.) and the columns representing lecture delivery method (i.e., face-to-face, online, and/or a mixture of both). If a significant ($p \leq 0.05$) difference was found with the initial analysis, then follow-up pairwise comparisons were conducted in order to evaluate the differences among the

proportions. If follow-up pairwise comparisons were made, a Holm's sequential Bonferroni correction method was used at the initial $p \leq 0.05$ level across all comparisons to control for Type I error.

Chapter 4: Results

Response Rate

The Anatomy 2300 course during the spring 2015 semester originally had 576 students enrolled in the course. Periodically during the beginning of the semester and during Unit I, 21 students dropped the course. At the administration of the ILS and demographics survey, which was presented to enrolled and present students during the first laboratory session of Unit II, there were 555 students still registered for the course. Of these 555 students, 505 consented to the use of their data for the study. This indicates a 90.10% response rate for the demographics survey and preferred learning styles questionnaire.

Cleaning of Data

After the data was entered into Excel to create the study database, the data was cleaned overall as described in Chapter 3: Methods. Additionally, certain participants' data were removed from specific analyses of the study if they met certain specified criteria:

- Did not complete the ILS.
- Did not report their major/program.
- Did not report their gender.

- Did not report their lecture delivery method of choice for the unit being analyzed.
- Did not have a reported highest ACT composite score.
- Did not take the unit examination for the unit being analyzed.

Demographics of Participants

Demographic information is summarized in Table 1. Descriptive statistics were conducted to determine demographic characteristics for the non-random sample in the areas of gender, age, ethnicity, class section of Anatomy 2300, academic year, major, intended career plan, highest ACT composite scores, and whether or not a participant was an international student or a domestic student. Of the 505 Anatomy 2300 students reporting their gender, 77.2% were female and 22.8% were male. The ages of the 497 Anatomy 2300 participants reporting their date of birth ranged from 18 to 35 years of age as of February 23, 2015, with the mean being 19.83 (SD = 1.986) years of age. Of the 505 participants reporting their registered class section of Anatomy 2300, 43.2% reported enrollment in Anatomy 2300.01, 2.2% reported enrollment in Anatomy 2300.02, 28.1% reported enrollment in Anatomy 2300.03, and 26.5% reported enrollment in Anatomy 2300.04. Of the 505 Anatomy 2300 participants reporting academic year in school, 41.2% reported freshman, 27.7% reported sophomore, 14.3% reported junior, 13.1% reported senior, and 3.8% reported other (i.e. post- baccalaureate).

Next, participants were asked to report their intended profession after graduation. Of the study participants, 497 reported their intended profession after graduation. The largest reported intended professions after graduation included: 22.7% reported they plan

on becoming a nurse, 10.7% reported they plan on becoming a nurse practitioner, and 17.1% reported they plan on becoming a physician. These and other intended professions frequencies can be found in table 2.

Of the 505 Anatomy 2300 students reporting their ethnicities, 5% reported African-American (non-Hispanic), 7.3% reported Asian/Pacific Islanders, 80.4% reported Caucasian (non-Hispanic), 4.2% reported Latino or Hispanic, and 3.2% reported other. (Note: Students were informed that they were permitted to indicate more than one race or ethnic group.)

The remaining demographics were on international versus domestic students and highest ACT composite score. Of the 503 Anatomy 2300 students reporting whether or not they were an international student, 99.4% reported domestic students and 0.6% reported international students. The highest ACT composite scores of the 443 Anatomy 2300 participants ranged from a score of 15 to 35, with the mean composite score being 26.91 (SD = 3.465).

Table 1
Demographics for Anatomy 2300 Participants

Demographic Category	Frequency	Percent
Gender		
Male	116	22.8
Female	390	77.2
Enrolled Section of Anatomy 2300		
.01	218	43.2
.02	11	2.2
.03	142	28.1
.04	134	26.5
Academic Year		
Freshman	208	41.2
Sophomore	140	27.7
Junior	72	14.3
Senior	66	13.1
Other	19	3.8
Ethnicity		
African-American (non-Hispanic	25	5.0
Asian/Pacific Islander	37	7.3
Caucasian (non-Hispanic)	406	80.4
Latino or Hispanic	21	4.2
Other	16	3.2
International or Domestic Student		
Domestic	500	99.4
International	3	0.6

This table indicates demographic information of the Anatomy 2300 participants during the spring 2015 semester.

Table 2
Intended Profession/Careers of Anatomy 2300 Students After Graduation

Intended Profession/Career	Frequency	Percent
Athletic Trainer	15	3.0
Dental Hygienist	11	2.2
Dentist	21	4.2
Dietitian	21	4.2
Hospital Administrator	8	1.6
Nurse	113	22.7
Nurse Anesthetist	14	2.8
Nurse Practitioner	53	10.7
Occupational Therapist	13	2.6
Optometrist	3	0.6
Pharmacist	31	6.2
Physical Therapist	29	5.8
Physician	85	17.1
Physician's Assistant	19	3.8
Radiation Therapist	15	3.0
Radiologic Technician	6	1.2
Registered Nurse	14	2.8
Respiratory Therapist	4	0.8
Sonographer	2	0.4
Ultrasound Tech	2	0.4
Other*	18	3.6
Total	497	100.0

This table indicates all the reported, intended professions/careers of the Anatomy 2300 participants during the spring 2015 semester. Other* included multiple intended professions reported by only 1 student each.

Question 1: What is the predominant learning style of students in an undergraduate gross anatomy course?

Learning styles are summarized in Table 3. Descriptive statistics were conducted on the calculated scores for each of the learning style dimensions (active/reflective,

sensing/intuitive, visual/verbal, and sequential/global) of the 505 Anatomy 2300 participants determined through the Index of Learning Styles (ILS) questionnaire.

In the active/reflective (ACT/REF) dimension, 54.9% were found to be active learners, while 45.1% were found to be reflective learners. For the sensing/intuitive (SEN/INT) dimension, 85.1% were found to be sensing learners, while 14.9% were found to be intuitive learners. In the visual/verbal (VIS/VER) dimension, 81.2% were found to be visual learners, while 18.8% were found to be verbal learners. For the sequential/global (SEQ/GLO) dimension, 74.7% were found to be sequential learners, while 25.3% were found to be global learners.

Table 3
Preferred Learning Style of Anatomy 2300 Participants

Learning Style Dimension	Frequency	Percent
Reflective (REF)	228	45.1
Active (ACT)	**277**	**54.9**
Intuitive (INT)	75	14.9
Sensing (SEN)	**430**	**85.1**
Verbal (VER)	95	18.8
Visual (VIS)	**410**	**81.2**
Global (GLO)	128	25.3
Sequential (SEQ)	**377**	**74.4**

This table shows the preferred learning style of all Anatomy 2300 participants (n = 505) from the spring 2015 semester that completed the ILS questionnaire. Each of the four dimensions, indicated by the ILS, are shown. The sub-dimensions bolded are the preferred learning style in that particular dimension.

Question 2: What is the predominant learning style of students within particular majors/programs that are registered for an undergraduate gross anatomy course?

In order to develop a profile of the preferred learning styles of the different majors/programs of students enrolled in Anatomy 2300, a determination of the majors of the enrolled students was necessary. To do this, descriptive statistics were conducted to determine all the reported majors of the 506 Anatomy 2300 participants. The frequencies of reported majors/programs can be found in Table 4 with Pre-Nursing, Pre-Medicine, and Pre-Health Science being the highest reported majors. The majors reported by only one student were indicated by the category "other" (n = 14), so those particular students cannot be identified.

Once the frequency of all the enrolled majors/programs was calculated, a learning styles profile for each major was constructed. Descriptive statistics were implemented on each major/program by utilizing the select cases function in SPSS. Each respective major was selected and frequencies were constructed for of the learning style dimensions. Tables 5 through 30, indicate the learning style dimensions for each major that had more than one participant enrolled. Majors that only had one enrolled participant were not scored as the category "other" included a myriad of different majors.

Table 4

Reported Majors/Programs of Anatomy 2300 Participants

Major/Program	Frequency	Percent
Pre-Athletic Training	27	5.3
Pre-Exercise Science	12	2.4
Pre-Health Science	50	9.9
Pre-Dental Hygiene	16	3.2
Pre-Medicine	72	14.2
Pre-Nursing	161	31.8
Pre-Radiologic Sciences & Therapy	30	5.9
Respiratory Science	5	1.0
Biochemistry	2	0.4
Biology	8	1.6
Chemical Engineering	2	0.4
Chemistry	2	0.4
Continuing Education	2	0.4
Dietetics	3	0.6
Exploration	4	0.8
Pre-Health Information Management & Systems (HIMS)	8	1.6
Human Development and Family Science	5	1.0
Human Nutrition	13	2.6
Medical Dietetics	7	1.4
Neuroscience	7	1.4
Pharmacy	21	4.2
Pre-dental	2	0.4
Pre-Pharmacy	3	0.6
Psychology	6	1.2
Public Health	2	0.4
Undeclared	22	4.3
Other*	14	2.8
Total	506	100.0

This table indicates all the reported, majors/programs of the Anatomy 2300 participants during the spring 2015 semester. Other* included multiple majors reported by only 1 student each.

Table 5

Pre-Athletic Training Reported Preferred Learning Styles

Learning Style	Frequency	Percent	Divergence from the Mean Percentage
Reflective	11	40.7	-4.4
Active	**16**	**59.3**	**+4.4**
Intuitive	6	22.2	+7.3
Sensing	**21**	**77.8**	**-7.3**
Verbal	6	22.2	+3.4
Visual	**21**	**77.8**	**-3.4**
Global	9	33.3	+8.0
Sequential	**18**	**66.7**	**-7.7**

This table shows the reported preferred learning styles of Pre-Athletic Training majors (n=27) enrolled in Anatomy 2300 during the spring 2015 semester that completed the ILS questionnaire. Each of the four dimensions, determined by the ILS questionnaire, are shown. The sub-dimensions bolded are the preferred learning style for that particular dimension for that particular major/program.

Table 6

Pre-Exercise Science Reported Preferred Learning Styles

Learning Style	Frequency	Percent	Divergence from the Mean Percentage
Reflective	**7**	**58.3**	**+13.2**
Active	5	41.7	-13.2
Intuitive	1	8.3	-6.6
Sensing	**11**	**91.7**	**+6.6**
Verbal	3	25.0	+6.2
Visual	**9**	**75.0**	**-6.2**
Global	2	16.7	-8.6
Sequential	**10**	**83.3**	**+8.9**

This table shows the reported preferred learning styles of Pre-Exercise Science majors (n=12) enrolled in Anatomy 2300 during the spring 2015 semester that completed the ILS questionnaire. Each of the four dimensions, determined by the ILS questionnaire, are shown. The sub-dimensions bolded are the preferred learning style for that particular dimension for that particular major/program.

Table 7
Pre-Health Science Reported Preferred Learning Styles

Learning Style	Frequency	Percent	Divergence from the Mean Percentage
Reflective	19	38.0	-7.1
Active	**31**	**62.0**	**+7.1**
Intuitive	9	18.0	+3.1
Sensing	**41**	**82.0**	**-3.1**
Verbal	5	10.0	-8.8
Visual	**45**	**90.0**	**+8.8**
Global	11	22.0	-3.3
Sequential	**39**	**78.0**	**+3.6**

This table shows the reported preferred learning styles of Health Science majors (n=50) enrolled in Anatomy 2300 during the spring 2015 semester that completed the ILS questionnaire. Each of the four dimensions, determined by the ILS questionnaire, are shown. The sub-dimensions bolded are the preferred learning style for that particular dimension for that particular major/program.

Table 8
Pre-Dental Hygiene Reported Preferred Learning Styles

Learning Style	Frequency	Percent	Divergence from the Mean Percentage
Reflective	5	31.3	-13.8
Active	**11**	**68.8**	**+13.9**
Intuitive	3	18.8	+3.9
Sensing	**13**	**81.3**	**-3.8**
Verbal	1	6.3	-12.5
Visual	**15**	**93.8**	**+12.6**
Global	1	6.3	-19.0
Sequential	**15**	**93.8**	**+19.4**

This table shows the reported preferred learning styles of Pre-Dental Hygiene majors (n=16) enrolled in Anatomy 2300 during the spring 2015 semester that completed the ILS questionnaire. Each of the four dimensions, determined by the ILS questionnaire, are

shown. The sub-dimensions bolded are the preferred learning style for that particular dimension for that particular major/program.

Table 9
Pre-Medicine Reported Preferred Learning Styles

Learning Style	Frequency	Percent	Divergence from the Mean Percentage
Reflective	**41**	**56.9**	**+11.8**
Active	31	43.1	-11.8
Intuitive	12	16.7	+1.8
Sensing	**60**	**83.4**	**-1.7**
Verbal	17	23.6	+4.8
Visual	**55**	**76.4**	**-4.8**
Global	21	29.2	+3.9
Sequential	**51**	**70.8**	**-3.6**

This table shows the reported preferred learning styles of Pre-Medicine majors (n=72) enrolled in Anatomy 2300 during the spring 2015 semester that completed the ILS questionnaire. Each of the four dimensions, determined by the ILS questionnaire, are shown. The sub-dimensions bolded are the preferred learning style for that particular dimension for that particular major/program

Table 10
Pre-Nursing Reported Preferred Learning Styles

Learning Style	Frequency	Percent	Divergence from the Mean Percentage
Reflective	70	43.5	-1.6
Active	**91**	**56.5**	**+1.6**
Intuitive	22	13.7	-1.2
Sensing	**139**	**86.3**	**+1.2**
Verbal	32	19.9	+1.1
Visual	**129**	**80.1**	**-1.1**
Global	46	28.6	+3.3
Sequential	**115**	**71.4**	**-3.0**

This table shows the reported preferred learning styles of Pre-Nursing majors (n=161) enrolled in Anatomy 2300 during the spring 2015 semester that completed the ILS questionnaire. Each of the four dimensions, determined by the ILS questionnaire, are shown. The sub-dimensions bolded are the preferred learning style for that particular dimension for that particular major/program.

Table 11
Pre-Radiologic Sciences & Therapy Reported Preferred Learning Styles

Learning Style	Frequency	Percent	Divergence from the Mean Percentage
Reflective	13	43.3	-1.8
Active	**17**	**56.7**	**+1.8**
Intuitive	5	16.7	+1.8
Sensing	**25**	**83.3**	**-1.8**
Verbal	5	16.7	-2.1
Visual	**25**	**83.3**	**+2.1**
Global	7	23.3	-2.0
Sequential	**23**	**76.7**	**+2.3**

This table shows the reported preferred learning styles of Radiologic Sciences & Therapy majors (n=30) enrolled in Anatomy 2300 during the spring 2015 semester that completed the ILS questionnaire. Each of the four dimensions, determined by the ILS questionnaire, are shown. The sub-dimensions bolded are the preferred learning style for that particular dimension for that particular major/program.

Table 12
Respiratory Therapy Reported Preferred Learning Styles

Learning Style	Frequency	Percent	Divergence from the Mean Percentage
Reflective	2	40.0	-5.1
Active	**3**	**60.0**	**+5.1**
Intuitive	0	0.0	-14.9
Sensing	**5**	**100.0**	**+14.9**
Verbal	2	40.0	+21.2
Visual	**3**	**60.0**	**-21.2**

continued

Table 12: Continued

Global	0	0.0	-25.3
Sequential	**5**	**100.0**	**+25.6**

This table shows the reported preferred learning styles of Respiratory Therapy majors (n=5) enrolled in Anatomy 2300 during the spring 2015 semester that completed the ILS questionnaire. Each of the four dimensions, determined by the ILS questionnaire, are shown. The sub-dimensions bolded are the preferred learning style for that particular dimension for that particular major/program.

Table 13

Biochemistry Reported Preferred Learning Styles

Learning Style	Frequency	Percent	Divergence from the Mean Percentage
Reflective	**2**	**100.0**	**+54.9**
Active	0	0.0	-54.9
Intuitive	0	0.0	-14.9
Sensing	**2**	**100.0**	**+14.9**
Verbal	1	50.0	+31.2
Visual	1	50.0	-31.2
Global	1	50.0	+24.7
Sequential	1	50.0	-24.4

This table shows the reported preferred learning styles of Biochemistry majors (n=2) enrolled in Anatomy 2300 during the spring 2015 semester that completed the ILS questionnaire. Each of the four dimensions, determined by the ILS questionnaire, are shown. The sub-dimensions bolded are the preferred learning style for that particular dimension for that particular major/program.

Table 14

Biology Reported Preferred Learning Styles

Learning Style	Frequency	Percent	Divergence from the Mean Percentage
Reflective	**6**	**75.0**	**+29.9**
Active	2	25.0	-29.9
Intuitive	1	12.5	-2.4
Sensing	**7**	**87.5**	**+2.4**

continued

Table 14: Continued

Verbal	3	37.5	+18.7
Visual	**5**	**62.5**	**-18.7**
Global	3	37.5	+12.2
Sequential	**5**	**62.5**	**-11.9**

This table shows the reported preferred learning styles of Biology majors (n=8) enrolled in Anatomy 2300 during the spring 2015 semester that completed the ILS questionnaire. Each of the four dimensions, determined by the ILS questionnaire, are shown. The sub-dimensions bolded are the preferred learning style for that particular dimension for that particular major/program.

Table 15

Pharmacy Reported Preferred Learning Styles

Learning Style	Frequency	Percent	Divergence from the Mean Percentage
Reflective	**13**	**61.9**	**+16.8**
Active	8	38.1	-16.8
Intuitive	1	4.8	-10.1
Sensing	**20**	**95.2**	**+10.1**
Verbal	1	4.8	-14.0
Visual	**20**	**95.2**	**+14.0**
Global	4	19.1	-6.2
Sequential	**17**	**82.0**	**+7.6**

This table shows the reported preferred learning styles of Pharmacy majors (n=21) enrolled in Anatomy 2300 during the spring 2015 semester that completed the ILS questionnaire. Each of the four dimensions, determined by the ILS questionnaire, are shown. The sub-dimensions bolded are the preferred learning style for that particular dimension for that particular major/program.

Table 16

Chemical Engineering Reported Preferred Learning Styles

Learning Style	Frequency	Percent	Divergence from the Mean Percentage
Reflective	1	50.0	+4.9
Active	1	50.0	-4.9

continued

Table 16: Continued

Intuitive	1	50.0	+35.1
Sensing	1	50.0	-35.1
Verbal	0	0.0	-18.8
Visual	**2**	**100.0**	**+18.8**
Global	0	0.0	-25.3
Sequential	**2**	**100.0**	**+25.6**

This table shows the reported preferred learning styles of Chemical Engineering majors (n=2) enrolled in Anatomy 2300 during the spring 2015 semester that completed the ILS questionnaire. Each of the four dimensions, determined by the ILS questionnaire, are shown. The sub-dimensions bolded are the preferred learning style for that particular dimension for that particular major/program.

Table 17

Chemistry Reported Preferred Learning Styles

Learning Style	Frequency	Percent	Divergence from the Mean Percentage
Reflective	0	0.0	-45.1
Active	**2**	**100.0**	**+45.1**
Intuitive	0	0.0	-14.9
Sensing	**2**	**100.0**	**+14.9**
Verbal	1	50.0	+31.2
Visual	1	50.0	-31.2
Global	1	50.0	+24.7
Sequential	1	50.0	-24.4

This table shows the reported preferred learning styles of Chemistry majors (n=2) enrolled in Anatomy 2300 during the spring 2015 semester that completed the ILS questionnaire. Each of the four dimensions, determined by the ILS questionnaire, are shown. The sub-dimensions bolded are the preferred learning style for that particular dimension for that particular major/program.

Table 18

Continuing Education Reported Preferred Learning Styles

Learning Style	Frequency	Percent	Divergence from the Mean Percentage
Reflective	0	0.0	-45.1
Active	**2**	**100.0**	**+45.1**
Intuitive	1	50.0	+35.1
Sensing	1	50.0	-35.1
Verbal	1	50.0	+31.2
Visual	1	50.0	-31.2
Global	1	50.0	+24.7
Sequential	1	50.0	-24.4

This table shows the reported preferred learning styles of Continuing Education majors (n=2) enrolled in Anatomy 2300 during the spring 2015 semester that completed the ILS questionnaire. Each of the four dimensions, determined by the ILS questionnaire, are shown. The sub-dimensions bolded are the preferred learning style for that particular dimension for that particular major/program.

Table 19

Dietetics Reported Preferred Learning Styles

Learning Style	Frequency	Percent	Divergence from the Mean Percentage
Reflective	1	33.3	-11.8
Active	**2**	**66.7**	**+11.8**
Intuitive	1	33.3	+18.4
Sensing	**2**	**66.7**	**-18.4**
Verbal	1	33.3	+14.5
Visual	**2**	**66.7**	**-14.5**
Global	1	33.3	+8.0
Sequential	**2**	**66.7**	**-7.7**

This table shows the reported preferred learning styles of Dietetics majors (n=3) enrolled in Anatomy 2300 during the spring 2015 semester that completed the ILS questionnaire. Each of the four dimensions, determined by the ILS questionnaire, are shown. The sub-dimensions bolded are the preferred learning style for that particular dimension for that particular major/program.

Table 20

Exploration Reported Preferred Learning Styles

Learning Style	Frequency	Percent	Divergence from the Mean Percentage
Reflective	1	25.0	-20.1
Active	**3**	**75.0**	**+20.1**
Intuitive	1	25.0	+10.1
Sensing	**3**	**75.0**	**-10.1**
Verbal	0	0.0	-18.8
Visual	**4**	**100.0**	**+18.8**
Global	0	0.0	-25.3
Sequential	**4**	**100.0**	**+25.3**

This table shows the reported preferred learning styles of Exploration majors (n=4) enrolled in Anatomy 2300 during the spring 2015 semester that completed the ILS questionnaire. Each of the four dimensions, determined by the ILS questionnaire, are shown. The sub-dimensions bolded are the preferred learning style for that particular dimension for that particular major/program.

Table 21

Human Development and Family Science (HDFS) Reported Preferred Learning Styles

Learning Style	Frequency	Percent	Divergence from the Mean Percentage
Reflective	2	40.0	-5.1
Active	**3**	**60.0**	**+5.1**
Intuitive	1	20.0	+5.1
Sensing	**4**	**80.0**	**-5.1**
Verbal	1	20.0	+1.2
Visual	**4**	**80.0**	**-1.2**
Global	1	20.0	-5.3
Sequential	**4**	**80.0**	**+5.6**

This table shows the reported preferred learning styles of HDFS majors (n=5) enrolled in Anatomy 2300 during the spring 2015 semester that completed the ILS questionnaire.

Each of the four dimensions, determined by the ILS questionnaire, are shown. The sub-dimensions bolded are the preferred learning style for that particular dimension for that particular major/program.

Table 22
Pre-Health Information Management & Systems (HIMS) Reported Preferred Learning Styles

Learning Style	Frequency	Percent	Divergence from the Mean Percentage
Reflective	3	37.5	-7.6
Active	**5**	**62.5**	**+7.6**
Intuitive	0	0.0	-14.9
Sensing	**8**	**100.0**	**+14.9**
Verbal	1	12.5	-6.3
Visual	**7**	**87.5**	**+6.3**
Global	3	37.5	+12.2
Sequential	**5**	**62.5**	**-11.9**

This table shows the reported preferred learning styles of HIMS majors (n=8) enrolled in Anatomy 2300 during the spring 2015 semester that completed the ILS questionnaire. Each of the four dimensions, determined by the ILS questionnaire, are shown. The sub-dimensions bolded are the preferred learning style for that particular dimension for that particular major/program.

Table 23
Nutrition Reported Preferred Learning Styles

Learning Style	Frequency	Percent	Divergence from the Mean Percentage
Reflective	3	23.1	-22.0
Active	**10**	**76.9**	**+22.0**
Intuitive	3	23.1	+8.2
Sensing	**10**	**76.9**	**-8.2**
Verbal	2	15.4	-3.4

continued

Table 23: Continued

Visual	**11**	**84.6**	**+3.4**
Global	6	46.2	+20.9
Sequential	**7**	**53.9**	**-20.5**

This table shows the reported preferred learning styles of Nutrition majors (n=13) enrolled in Anatomy 2300 during the spring 2015 semester that completed the ILS questionnaire. Each of the four dimensions, determined by the ILS questionnaire, are shown. The sub-dimensions bolded are the preferred learning style for that particular dimension for that particular major/program.

Table 24

Medical Dietetics Reported Preferred Learning Styles

Learning Style	Frequency	Percent	Divergence from the Mean Percentage
Reflective	3	42.9	-2.2
Active	**4**	**57.1**	**+2.2**
Intuitive	0	0.0	-14.9
Sensing	**7**	**100.0**	**+14.9**
Verbal	1	14.3	-4.5
Visual	**6**	**85.7**	**+4.5**
Global	3	42.9	+17.6
Sequential	**4**	**57.1**	**-17.3**

This table shows the reported preferred learning styles of Medical Dietetics majors (n=7) enrolled in Anatomy 2300 during the spring 2015 semester that completed the ILS questionnaire. Each of the four dimensions, determined by the ILS questionnaire, are shown. The sub-dimensions bolded are the preferred learning style for that particular dimension for that particular major/program.

Table 25

Neuroscience Reported Preferred Learning Styles

Learning Style	Frequency	Percent	Divergence from the Mean Percentage
Reflective	**4**	**57.1**	**+12.0**
Active	3	42.9	-12.0
Intuitive	0	0.0	-14.9
Sensing	**7**	**100.0**	**+14.9**
Verbal	2	28.6	+9.8
Visual	**5**	**71.4**	**-9.8**
Global	0	0.0	-25.3
Sequential	**7**	**100.0**	**+25.3**

This table shows the reported preferred learning styles of Neuroscience majors (n=7) enrolled in Anatomy 2300 during the spring 2015 semester that completed the ILS questionnaire. Each of the four dimensions, determined by the ILS questionnaire, are shown. The sub-dimensions bolded are the preferred learning style for that particular dimension for that particular major/program.

Table 26

Pre-Dental Reported Preferred Learning Styles

Learning Style	Frequency	Percent	Divergence from the Mean Percentage
Reflective	0	0.0	-45.1
Active	**2**	**100.0**	**+45.1**
Intuitive	0	0.0	-14.9
Sensing	**2**	**100.0**	**+14.9**
Verbal	0	0.0	-18.8
Visual	**2**	**100.0**	**+18.8**
Global	0	0.0	-25.3
Sequential	**2**	**100.0**	**+25.3**

This table shows the reported preferred learning styles of Pre-Dental majors (n=2) enrolled in Anatomy 2300 during the spring 2015 semester that completed the ILS questionnaire. Each of the four dimensions, determined by the ILS questionnaire, are

shown. The sub-dimensions bolded are the preferred learning style for that particular dimension for that particular major/program.

Table 27
Pre-Pharmacy Reported Preferred Learning Styles

Learning Style	Frequency	Percent	Divergence from the Mean Percentage
Reflective	**3**	**100.0**	**+54.9**
Active	0	0.0	-54.9
Intuitive	0	0.0	-14.9
Sensing	**3**	**100.0**	**+14.9**
Verbal	1	33.3	+14.5
Visual	**2**	**66.7**	**-14.5**
Global	0	0.0	-25.3
Sequential	**3**	**100.0**	**+25.3**

This table shows the reported preferred learning styles of Pre-Pharmacy majors (n=3) enrolled in Anatomy 2300 during the spring 2015 semester that completed the ILS questionnaire. Each of the four dimensions, determined by the ILS questionnaire, are shown. The sub-dimensions bolded are the preferred learning style for that particular dimension for that particular major/program.

Table 28
Psychology Reported Preferred Learning Styles

Learning Style	Frequency	Percent	Divergence from the Mean Percentage
Reflective	2	33.3	-11.8
Active	**4**	**66.7**	**+11.8**
Intuitive	2	33.3	+18.4
Sensing	**4**	**66.7**	**-18.4**
Verbal	0	0.0	-18.8
Visual	**6**	**100.0**	**+18.8**

continued

Table 28: Continued

Global	1	16.7	-8.6
Sequential	**5**	**83.3**	**+8.9**

This table shows the reported preferred learning styles of Psychology majors (n=6) enrolled in Anatomy 2300 during the spring 2015 semester that completed the ILS questionnaire. Each of the four dimensions, determined by the ILS questionnaire, are shown. The sub-dimensions bolded are the preferred learning style for that particular dimension for that particular major/program.

Table 29

Public Health Reported Preferred Learning Styles

Learning Style	Frequency	Percent	Divergence from the Mean Percentage
Reflective	**2**	**100.0**	**+54.9**
Active	0	0.0	-54.9
Intuitive	0	0.0	-14.9
Sensing	**2**	**100.0**	**+14.9**
Verbal	0	0.0	-18.8
Visual	**2**	**100.0**	**+18.8**
Global	1	50.0	+24.7
Sequential	1	50.0	-24.4

This table shows the reported preferred learning styles of Public Health majors (n=2) enrolled in Anatomy 2300 during the spring 2015 semester that completed the ILS questionnaire. Each of the four dimensions, determined by the ILS questionnaire, are shown. The sub-dimensions bolded are the preferred learning style for that particular dimension for that particular major/program.

Table 30

Undeclared Reported Preferred Learning Styles

Learning Style	Frequency	Percent	Divergence from the Mean Percentage
Reflective	9	40.9	-4.2
Active	**13**	**59.1**	**+4.2**

continued

Table 30: Continued

Intuitive	4	18.2	+3.3
Sensing	**18**	**81.8**	**-3.3**
Verbal	5	22.7	+3.9
Visual	**17**	**77.3**	**-3.9**
Global	2	9.1	-16.2
Sequential	**20**	**90.9**	**+16.5**

This table shows the reported preferred learning styles of Undeclared majors (n=22) enrolled in Anatomy 2300 during the spring 2015 semester that completed the ILS questionnaire. Each of the four dimensions, determined by the ILS questionnaire, are shown. The sub-dimensions bolded are the preferred learning style for that particular dimension for that particular major/program.

Question 3: Are there gender differences in preferred learning styles in an undergraduate gross anatomy course?

Before any analyses were conducted to determine gender differences in preferred learning styles, descriptive statistics were conducted to determine the frequency of each preferred learning style dimension for males (n = 116) and females (n = 390). Of the 390 female Anatomy 2300 students completing the ILS questionnaire, for the active/reflective dimension, 42% were reflective learners, while 58% were active learners. For the 116 males in Anatomy 2300 completing the ILS questionnaire, for the active/reflective dimension, 55% were reflective learners, while 45% were active learners. Of the 390 female Anatomy 2300 students completing the ILS questionnaire, for the sensing/intuitive dimension, 15% were intuitive learners, while 85% were sensing learners. For the 116 males in Anatomy 2300 completing the ILS questionnaire, for the sensing/intuitive dimension, 14% were intuitive learners, while 86% were sensing learners. Of the 390 female Anatomy 2300 students completing the ILS questionnaire,

for the visual/verbal dimension, 20% were verbal learners, while 80% were visual learners. For the 116 males in Anatomy 2300 completing the ILS questionnaire, for the visual/verbal dimension, 14% were verbal learners, while 86% were visual learners. Of the 390 female Anatomy 2300 students completing the ILS questionnaire, for the sequential/global dimension, 26% were global learners, while 74% were sequential learners. For the 116 males in Anatomy 2300 completing the ILS questionnaire, for the sequential/global dimension, 24% were global learners, while 76% were sequential learners. Table 31 provides a summary of the previous data.

Table 31

Preferred Learning Style of Female & Male Anatomy 2300 Participants

Learning Style Dimension	Female	Male
Reflective (REF)	164	**64**
Active (ACT)	**226**	52
Intuitive (INT)	59	16
Sensing (SEN)	**331**	**100**
Verbal (VER)	79	16
Visual (VIS)	**311**	**100**
Global (GLO)	100	28
Sequential (SEQ)	**290**	**88**

This table shows the preferred learning style of female and male Anatomy 2300 participants (female n = 390; male n = 116) from the spring 2015 semester that completed the ILS questionnaire. Each of the four dimensions, indicated by the ILS, are shown. The numbers bolded are the preferred learning style in that particular dimension.

Four individual two-way contingency table analyses were conducted to evaluate whether there were gender differences in the four learning style dimensions, active/reflective, sensing/intuitive, visual/verbal, and sequential/global for the Anatomy 2300 spring 2015 class. Because the four learning style dimensions were determined to be one instrument (i.e. the ILS), $p \leq 0.0125$ was set in order to spread the significance throughout the four dimensions of the instrument.

A two-way contingency table was used to determine whether there was a significant difference between males and females in their preferred learning style within the active/reflective (ACT/REF) dimension. The contingency table's variables were gender (i.e., male and female) and the learning style dimension (i.e., active and reflective). Gender and the active/reflective learning style dimension were found to have a statistically significant relationship [Pearson $\chi^2(1, n = 506) = 6.22$, $p = 0.01$, $\phi = -0.11$].

A two-way contingency table was used to determine whether there was a significant difference between males and females in their preferred learning style within the sensing/intuitive (SEN/INT) dimension. The contingency table's variables were gender (i.e., male and female) and the learning style dimension (i.e., sensing and intuitive). Gender and the sensing/intuitive learning style dimension were found to not have a statistically significant relationship [Pearson $\chi^2(1, n = 506) = 0.13$, $p = 0.72$, $\phi = 0.12$].

A two-way contingency table was used to determine whether there was a significant difference between males and females in their preferred learning style within

the visual/verbal (VIS/VER) dimension. The contingency table included the variables gender (i.e., male and female) and the learning style dimension (i.e., visual and verbal). Gender and the visual/verbal learning style dimension were found to not have a statistically significant relationship [Pearson $\chi^2(1, n = 506) = 2.45$, $p = 0.12$, $\phi = 0.07$].

A two-way contingency table was used to determine whether there was a significant difference between males and females in their preferred learning style within the sequential/global (SEQ/GLO) dimension. The contingency table included the variables gender (i.e., male and female) and the learning style dimension (i.e., sequential and global). Gender and the sequential/global learning style dimension were found to not have a statistically significant relationship [Pearson $\chi^2(1, n = 506) = 0.11$, $p = 0.74$, $\phi = 0.02$].

Question 4: Is there a difference in preferred lecture delivery method between the three respective units?

Before any analyses were conducted to determine if there was a difference between preferred lecture delivery method of choice between the three curricular units, descriptive statistics were conducted in order to determine the frequency of each preferred lecture delivery method of choice for each of the three units of information. Of the 442 Anatomy 2300 students reporting their lecture delivery method of choice for Unit II – Back & Upper Limb, 28.7% reported utilizing only the face-to-face lectures, 45.7% reported utilizing only the online lectures, and 25.6% reported utilizing a mixture of both the face-to-face lectures and the online lectures (Figure 1). Of the 430 Anatomy 2300 students reporting their lecture delivery method of choice for Unit III – Head & Neck,

24.2% reported utilizing only the face-to-face lectures, 52.6% reported utilizing only the online lectures, and 23.3% reported utilizing a mixture of both the face-to-face lectures and the online lectures (Figure 2). Of the 397 Anatomy 2300 students reporting their lecture delivery method of choice for Unit IV – Thorax, Abdomen, & Pelvis, 23.9% reported utilizing only the face-to-face lectures, 54.9% reported utilizing only the online lectures, and 21.2% reported utilizing a mixture of both the face-to-face lectures and the online lectures (Figure 3). Table 32 provides a summary of the previous data.

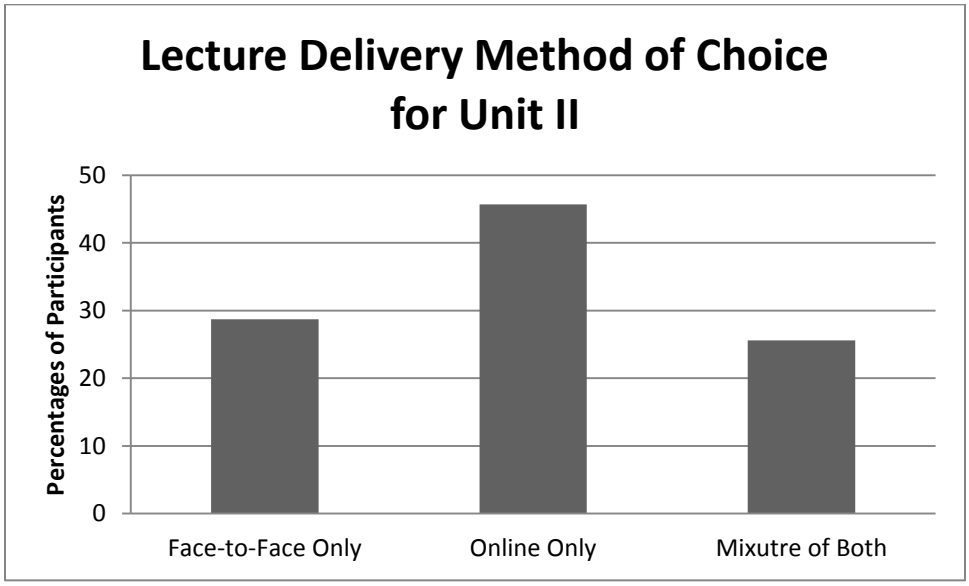

Figure 1. Lecture Delivery Method of Choice for Unit II. This figure depicts the percentages of participants (n = 442) who reported their lecture delivery method of choice for Unit II – Back & Upper Limb.

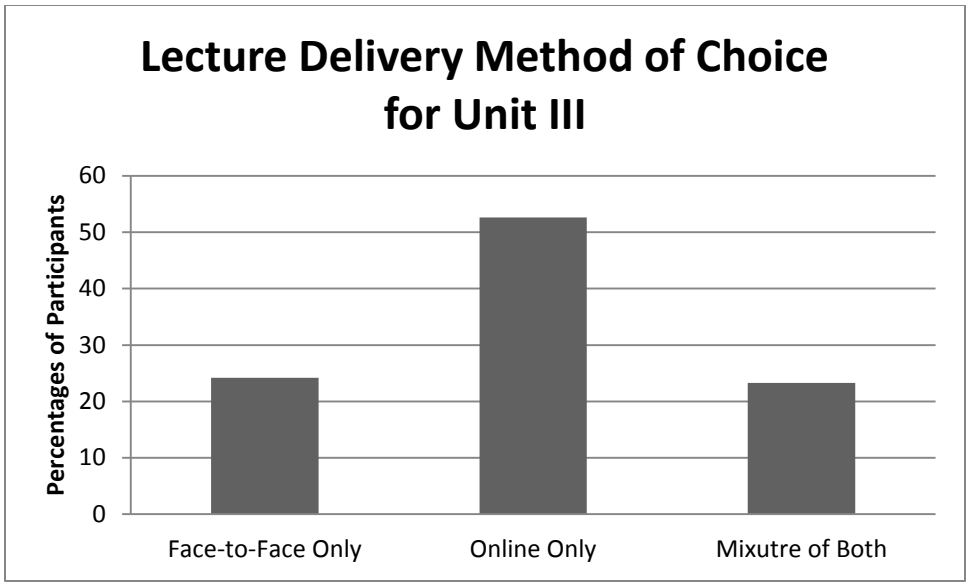

Figure 2. Lecture Delivery Method of Choice for Unit III. This figure depicts the percentages of participants (n = 430) who reported their lecture delivery method of choice for Unit III – Head & Neck.

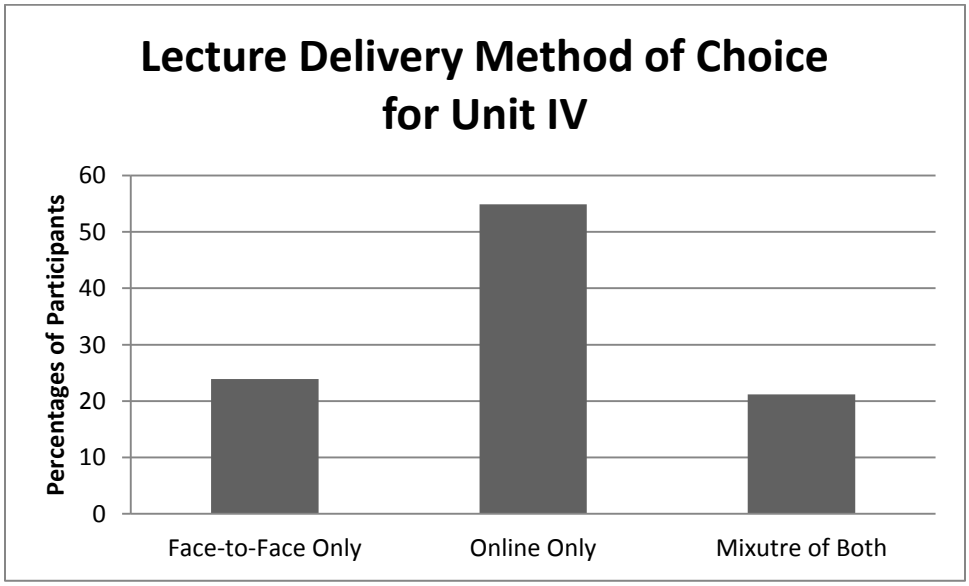

Figure 3. Lecture Delivery Method of Choice for Unit IV. This figure depicts the percentages of participants (n = 397) who reported their lecture delivery method of choice for Unit IV – Thorax, Abdomen, & Pelvis.

Table 32
Preferred Lecture Delivery Method per Curricular Unit of Anatomy 2300

Curricular Unit	Face-to-Face Only	Online Only	Mixture of Both
Unit II (Back & Upper Limb)	127	202	113
Unit III (Head & Neck)	104	226	100
Unit IV (Thorax, Abdomen, & Pelvis)	95	218	84

This table shows the preferred lecture delivery method for Anatomy 2300 participants per curricular unit (Unit II n = 442; Unit III n= 430; Unit IV = 397). Each of the three choices for lecture delivery method are shown. The numbers bolded are the preferred lecture delivery method for that particular curricular unit.

After the frequencies were determined, a two-way contingency table analysis was conducted to determine whether there was a difference in lecture delivery method of choice between the three units of information in Anatomy 2300. The two variables were lecture delivery method of choice (i.e., face-to-face only, online only, or a mixture of both) and the three curricular units of information in Anatomy 2300 (i.e., Unit II, Unit III, and Unit IV). Overall, the lecture delivery method of choice and curricular unit of information in Anatomy 2300 was found to have a statistically significant relationship [Pearson $\chi^2(1, n = 1397) = 10.57$, $p = 0.03$, Cramér's $V = 0.06$]. Therefore, follow-up pairwise comparisons were conducted to determine location of the difference among these proportions. The Holm's sequential Bonferroni correction method was used to control for Type I error at the 0.05 level across all three comparisons, thus dropping the significance to $p \leq 0.01$. Table 30 shows the results of these analyses.

Table 33
Results for the Pairwise Comparisons Using the Holm's Sequential Bonferroni Correction Method for Lecture Delivery Method and Units II, III, and IV

Comparison	Pearson χ^2	p value (Alpha)
Unit II vs. Unit III	7.01	0.03
Unit II vs. Unit IV	0.33	0.85
Unit III vs. Unit IV	6.92	0.03

This table indicates the results of the follow-up pairwise testing utilizing the Bonferroni correction method.

Question 5: Does a student's preferred learning style predict academic achievement per respective unit within an undergraduate gross anatomy course, when controlling for academic ability?

To investigate whether a student's preferred learning style predicted exam score for the end of unit exam for each of three units in Anatomy 2300, multiple linear regression analyses were conducted for each Anatomy 2300 curricular unit in SPSS. For these analyses, academic ability was controlled. Academic ability for each student was defined by their highest ACT composite score. Any student meeting one or more of the following criteria were removed from each respective unit's analyses: 1) did not have a reported highest ACT composite score, 2) a reported highest ACT composite score "0", 3) did not take that respective unit's examination, and/or 4) did not have a score for their preferred learning style. Significance for analyses was set at $p \leq 0.05$.

Multiple linear regression analyses were conducted to determine if any of the learning style dimensions of a student predicted their examination score (i.e. academic

achievement) for Unit II, Unit III, and Unit IV in Anatomy 2300 when controlling for academic ability (i.e., highest ACT composite score). Four potential predictors were tested; those being the four dimensions of learning styles with the highest ACT composite score being the control. With the data cleaned, as described previously, 473 participants were retained for analysis for Unit II. Of those 473 participants, the mean highest ACT composite score was 26.95 (SD= 3.48), while the mean Unit II examination score was 79.94 (SD = 14.84). The results of the regression model for Unit II indicated the four predictors explained approximately 14% of the variance [$R^2 = 0.14$, $F(5,467) = 14.55$, $p < 0.01$], however, none of the learning style dimensions were statistically significant in predicting examination score. For analysis for Unit III, 465 participants were retained. Of those participants, the mean highest ACT composite score was 26.98 (SD= 3.47) while the mean Unit III examination score was 78.74 (SD = 15.42). The results of the regression model for Unit III indicated the four predictors explained approximately 16% of the variance [$R^2 = 0.16$, $F(5,459) = 17.82$, $p < 0.01$], while active/reflective dimension significantly predicted Unit III examination scores ($\beta = -3.32$, $p = 0.02$). For analysis for Unit IV, 457 participants were retained. Of those participants, the mean highest ACT composite score was 27.02 (SD= 3.45), while the mean Unit IV examination score was 84.84 (SD = 12.56. The results of the regression model indicated the four predictors explained approximately 13% of the variance [$R^2 = 0.13$, $F(5,451) = 13.88$, $p < 0.01$], however, none of the learning style dimensions were statistically significant in predicting examination score. It should be noted that the control variable of

highest ACT composite score was statistically significant in predicting examination scores for each of the units.

Question 6: Does a student's preferred learning style predict their lecture delivery method in an undergraduate gross anatomy course for each respective unit?

To examine whether a students preferred learning style predicts their choice in lecture delivery method for each of the three curricular units in Anatomy 2300, multinomial logistic regression analyses were conducted for Units II, III, and IV. Significance was set at $p \leq 0.05$ for all analyses.

The results of the logistic regression model for Unit II indicated that the overall model was significant [$\chi^2(8) = 19.47, p \leq 0.01$] and of all the predictor variables, only the sensing/intuitive dimension was a significant predictor of lecture delivery method of choice [$\chi^2(2) = 19.47, p < 0.01$]. The results of the logistic regression model for Unit III indicated that the overall model was significant [$\chi^2(8) = 21.07, p \leq 0.01$] and of all the predictor variables, only the sensing/intuitive dimension was a significant predictor of lecture delivery method of choice [$\chi^2(2) = 7.71, p < 0.01$]. The results of the logistic regression model for Unit IV indicated that the overall model was significant [$\chi^2(8) = 15.84, p = 0.05$] and, once again, of all the predictor variables, only the sensing/intuitive dimension was a significant predictor of lecture delivery method of choice [$\chi^2(2) = 8.82, p = 0.01$].

Question 7: Does lecture delivery method predict academic achievement on respective unit assessments in an undergraduate gross anatomy course when controlling for academic ability?

To investigate whether a student's lecture delivery method of choice predicted examination score for the end of unit exam for each of three curricular units in Anatomy 2300, multiple linear regression analyses were conducted for each unit in SPSS. Because categorical predictor variables (i.e. lecture delivery method of choice) cannot be entered directly into a regression model and be meaningfully interpreted, dummy coding was initially conducted in order to transform the categorical variable (i.e. lecture delivery method of choice) into dichotomous variables. In order to dummy code, the lecture delivery method of choice, initially coded as: 1 = face-to-face only, 2 = online only, 3 = mixture of both, was transformed into different variables with the transform function in SPSS. The first new variable was labeled *LDM_FACE,* where face-to-face was coded as "1", while the other categories were coded as a "0". The second dummy coded variable was labeled *LDM_ONLINE,* where online was coded "1", while the other categories were coded a "0". The third dummy coded variable was labeled *LDM_MIX*, where mixture of both was coded a "1" and the other categories were coded as a "0". Academic ability was controlled for in all analyses. Academic ability for each student was defined by their highest ACT composite score. Before the multiple regression analyses were to be conducted on Unit II, Unit III, and Unit IV, students who met one or more of the following criteria were removed from each respective unit's analysis: 1) did not have a reported highest ACT composite score, 2) had a reported highest ACT composite score of

"0", 3) did not take that respective unit's examination, and/or 4) did not report their lecture delivery method of choice. Significance for analyses was set at $p \leq 0.05$. Table 34 summarizes the mean unit examination scores and standard deviations for the different lecture delivery methods.

A multiple linear regression was conducted to determine if lecture delivery method of choice predicted student examination score (i.e. academic achievement) for Unit II – Back & Upper Limb in Anatomy 2300 when controlling for academic ability (i.e., highest ACT composite score). With the data cleaned, as described previously, 442 total participants were retained for analysis. Of those 442 participants, the mean highest ACT composite score was 27.00 (SD = 3.56) while the mean Unit II examination score was 80.28 (SD = 14.67). Unit II examination scores for the 127 face-to-face only students ranged from 12 to 100 with a mean Unit II examination score of 82.77 (SD = 14.81). Unit II examination scores for the 202 online only students ranged from 30 to 100 with a mean Unit II examination score of 79.24 (SD = 15.06). Unit II examination scores for the 113 students who utilized a mixture of both ranged from 40 to 100 with a mean Unit II examination score of 79.35 (SD = 13.41). The predictors were the dummy coded variables for lecture delivery method of choice while highest ACT composite score was the control. The results of the multiple linear regression model indicated the predictors explained approximately 14% of the variance [$R^2 = 0.14$, $F(3,438) = 22.90$, $p < 0.01$]. These results indicated that the face-to-face only lecture delivery method significantly predicted Unit II examination scores ($\beta = 4.28$, $p < 0.01$).

A multiple linear regression was conducted to determine if lecture delivery method of choice predicted student examination score (i.e. academic achievement) for Unit III – Head & Neck in Anatomy 2300 when controlling for academic ability (i.e., highest ACT composite score). With the data cleaned, as described previously, 430 total participants were retained for analysis. Of those 430 participants, the mean highest ACT composite score was 27.00 (SD = 3.49), while the mean Unit III examination score was 78.93 (SD = 15.44). Unit III examination scores for the 104 face-to-face only students ranged from 24 to 100 with a mean Unit III examination score of 83.19 (SD = 13.94). Unit III examination scores for the 226 online only students ranged from 38 to 100 with a mean Unit III examination score of 78.07 (SD = 15.34). Unit III examination scores for the 100 students who utilized a mixture of both ranged from 36 to 100 with a mean Unit III examination score of 76.42 (SD = 16.38). The predictors were the dummy coded variables for lecture delivery method of choice, while highest ACT composite score was the control. The results of the multiple linear regression model indicated the predictors explained approximately 18% of the variance [$R^2 = 0.18$, $F(3,426) = 30.57$, $p < 0.01$]. These results indicated that only the face-to-face only lecture delivery method significantly predicted Unit III examination scores ($\beta = 6.19$, $p < 0.01$).

A multiple linear regression was conducted to determine if lecture delivery method of choice predicted student exam score (i.e. academic achievement) for Unit IV – Thorax, Abdomen, & Pelvis in Anatomy 2300 when controlling for academic ability (i.e., highest ACT composite score). With the data cleaned, as described previously, 397 total participants were retained for analysis. Of those 397 participants, the mean highest ACT

composite score was 27.08 (SD = 3.44) while the mean Unit IV examination score was 85.21 (SD = 12.35). Unit IV examination scores for the 95 face-to-face only students ranged from 18 to 100 with a mean Unit IV examination score of 86.86 (SD = 12.40). Unit IV examination scores for the 218 online only students ranged from 34 to 100 with a mean Unit IV examination score of 84.77 (SD = 11.66). Unit IV examination scores for the 84 students who utilized a mixture of both ranged from 32 to 100 with a mean Unit IV examination score of 84.48 (SD = 13.91). The predictors were the dummy coded variables for lecture delivery method of choice, while highest ACT composite score was the control. The results of the multiple linear regression model indicated the predictors explained approximately 13% of the variance [$R^2 = 0.13$, $F(3,393) = 20.24$, $p < 0.01$], however, none of the lecture delivery methods significantly predicted examination scores. It should be noted that the control variable of highest ACT composite score was statistically significant in predicting examination scores for each of the units.

Table 34

Mean Unit Examination Scores for Different Lecture Delivery Methods

Curricular Unit	Mean Examination Score	Standard Deviation
Unit II – Back & Upper Limb	80.28	14.67
Face-to-Face Only	82.77	14.81
Online Only	79.24	15.06
Mixture of Both	79.35	13.41

continued

Table 34: Continued

Unit III – Head & Neck	78.93	15.44
Face-to-Face Only	83.19	13.94
Online Only	78.07	15.34
Mixture of Both	76.42	16.38
Unit IV – Thorax, Abdomen, & Pelvis	85.21	12.35
Face-to-Face Only	86.86	12.40
Online Only	84.77	11.66
Mixture of Both	84.48	13.91

This table shows the mean unit examination score and standard deviation for the three different lecture delivery methods.

Question 8: Is there a gender difference in lecture delivery method per respective unit in an undergraduate gross anatomy course?

Before any analyses were conducted to determine whether there was a gender difference in lecture delivery method per respective unit in Anatomy 2300, descriptive statistics were conducted in order to determine the frequency of each lecture delivery method of choice for males and females for each curricular unit. After three individual two-way contingency table analyses were conducted to evaluate whether there were gender differences in lecture delivery method of choice (i.e. face-to-face only, online only, or a mixture of both) for the each of the three curricular units for the Anatomy 2300 spring 2015 class. Tables 35 and 36 provide summary data for the number of male and females and their preferred lecture delivery method.

A two-way contingency table was used to determine whether there was a significant difference between males and females in their lecture delivery method of choice in Unit II. Of the 364 female Anatomy 2300 students who reported their lecture delivery method of choice for Unit II, 31% reported utilizing the face-to-face lectures only, 45% reported utilizing the online lectures only, and 24% reported utilizing a mixture of both the face-to-face lectures and the online lectures. For the 106 male Anatomy 2300 students who reported their lecture delivery method of choice for Unit II, 20% reported utilizing the face-to-face lectures only, 50% reported utilizing the online lectures only, and 30% reported utilizing a mixture of both the face-to-face lectures and the online lectures. The contingency table's variables were gender (i.e., male and female) and the lecture delivery method of choice (i.e., face-to-face only, online only, or a mixture of both) for Unit II. Gender and the lecture delivery method of choice for Unit II were found to not have a statistically significant relationship [Pearson $\chi^2(1, n = 470) = 5.14$, $p = 0.08$, Cramér's $V = 0.11$].

A two-way contingency table was used to determine whether there was a significant difference between males and females in their lecture delivery method of choice in Unit III. Of the 362 female Anatomy 2300 students who reported their lecture delivery method of choice for Unit III, 25% reported utilizing the face-to-face lectures only, 53% reported utilizing the online lectures only, and 22% reported utilizing a mixture of both the face-to-face lectures and the online lectures. For the 102 male Anatomy 2300 students who reported their lecture delivery method of choice for Unit III, 18% reported utilizing the face-to-face lectures only, 58% reported utilizing the online

lectures only, and 25% reported utilizing a mixture of both the face-to-face lectures and the online lectures. The contingency table's variables were gender (i.e., male and female) and the lecture delivery method of choice (i.e., face-to-face only, online only, or a mixture of both) for Unit III. Gender and the lecture delivery method of choice for Unit III were found to not have a statistically significant relationship [Pearson $\chi^2(1, n = 464) = 2.66$, $p = 0.26$, Cramér's $V = 0.08$].

A two-way contingency table was used to determine whether there was a significant difference between males and females in their lecture delivery method of choice in Unit IV. Of the 360 female Anatomy 2300 students who reported their lecture delivery method of choice for Unit IV, 26% reported utilizing the face-to-face lectures only, 54% reported utilizing the online lectures only, and 20% reported utilizing a mixture of both the face-to-face lectures and the online lectures. For the 103 male Anatomy 2300 students who reported their lecture delivery method of choice for Unit IV, 18% reported utilizing the face-to-face lectures only, 60% reported utilizing the online lectures only, and 22% reported utilizing a mixture of both the face-to-face lectures and the online lectures. The contingency table's variables were gender (i.e., male and female) and the lecture delivery method of choice (i.e., face-to-face only, online only, or a mixture of both) for Unit IV. Gender and the lecture delivery method of choice for Unit IV were found to not have a statistically significant relationship [Pearson $\chi^2(1, n = 463) = 2.01$, $p = 0.36$, Cramér's $V = 0.07$].

Table 35

Preferred Lecture Delivery Method per Curricular Unit of Anatomy 2300 for Female Participants

Curricular Unit	Face-to-Face Only	Online Only	Mixture of Both
Unit II – Back & Upper Limb	113	163	88
Unit III – Head & Neck	92	191	79
Unit IV – Thorax, Abdomen, & Pelvis	91	198	71

This table shows the raw data for the preferred lecture delivery method for female Anatomy 2300 participants per curricular unit (Unit II n = 364; Unit III n = 362; Unit IV n = 360). Each of the three choices for lecture delivery method are shown.

Table 36

Preferred Lecture Delivery Method per Curricular Unit of Anatomy 2300 for Male Participants

Curricular Unit	Face-to-Face Only	Online Only	Mixture of Both
Unit II – Back & Upper Limb	21	54	31
Unit III – Head & Neck	18	59	25
Unit IV – Thorax, Abdomen, & Pelvis	19	62	22

This table shows the raw data for the preferred lecture delivery method for male Anatomy 2300 participants per curricular unit (Unit II n = 106; Unit III n = 102; Unit IV n = 103). Each of the three choices for lecture delivery method are shown

Question 9: Do students in the three largest majors/programs have a difference in lecture delivery method per respective unit?

With the frequency of majors enrolled in the Anatomy 2300 course previously determined for question 2, the three largest (i.e. most participants enrolled) majors/programs was determined to be the Pre-Nursing, Pre-Medicine, and Pre-Health Sciences majors, respectively. Before any analyses were conducted descriptive statistics were conducted in order to determine the frequency of each lecture delivery method of choice for the Pre-Nursing, Pre-Medicine, and Pre-Health Sciences majors. With this information three individual two-way contingency tables were constructed, one for each unit of course content. Tables 38 through 40 provide summary data for the number of Pre-Nursing, Pre-Medicine, and Pre-Health Science majors and their preferred lecture delivery method per curricular unit.

A two-way contingency table was used to determine whether there was a significant difference between the three largest majors enrolled in the course in their lecture delivery method of choice for Unit II. Of the 149 Pre-Nursing majors enrolled in Anatomy 2300 who reported their lecture delivery method of choice for Unit II, 42% reported utilizing the face-to-face lectures only, 36% reported utilizing the online lectures only, and 22% reported utilizing a mixture of both the face-to-face lectures and the online lectures. For the 66 Pre-Medicine majors enrolled in Anatomy 2300 who reported their lecture delivery method of choice for Unit II, 23% reported utilizing the face-to-face lectures only, 53% reported utilizing the online lectures only, and 24% reported utilizing a mixture of both the face-to-face lectures and the online lectures. Finally, for the 44 Pre-

Health Sciences majors enrolled in Anatomy 2300 who reported their lecture delivery method of choice for Unit II, 23% reported utilizing the face-to-face lectures only, 55% reported utilizing the online lectures only, and 22% reported utilizing a mixture of both the face-to-face lectures and the online lectures. The contingency table's variables were the three largest majors enrolled in Anatomy 2300 (i.e., Pre-Nursing, Pre-Medicine, and Pre-Health Sciences) and lecture delivery method of choice (i.e., face-to-face only, online only, or a mixture of both) for Unit II. The three largest majors enrolled and their lecture delivery method of choice for Unit II were determined to have a statistically significant relationship [Pearson $\chi^2(4, n = 259) = 12.00$, $p = 0.02$, Cramér's $V = 0.15$]. In order to determine between which majors the significance was located, follow-up pairwise comparisons were conducted to evaluate the difference among these proportions. Table 31 shows the results of these analyses. The Holm's sequential Bonferroni correction method was used to control for Type I error at the 0.05 level across all three comparisons by reducing significance to 0.01. The results of the Bonferroni correction method indicated there was not a statistical significance between the different majors.

Table 37
Results for the Pairwise Comparisons Using the Holm's Sequential Bonferroni Correction Method for Lecture Delivery Method and Pre-Nursing, Pre-Medicine, and Health Science Majors

Comparison	Pearson χ^2	p value (Alpha)
Pre-Nursing vs. Pre-Medicine	8.32	0.02
Pre-Nursing vs. Pre-Health Sciences	6.51	0.04
Pre-Medicine vs. Pre-Health Sciences	0.04	0.10

This table indicates the results for the pairwise comparisons using the Holm's sequential Bonferroni correction method.

A two-way contingency table was used to determine whether there was a significant difference between the three largest majors enrolled in the course in their lecture delivery method of choice for Unit III. Of the 150 Pre-Nursing majors enrolled in Anatomy 2300 who reported their lecture delivery method of choice for Unit III, 31% reported utilizing the face-to-face lectures only, 47% reported utilizing the online lectures only, and 22% reported utilizing a mixture of both the face-to-face lectures and the online lectures. For the 66 Pre-Medicine majors enrolled in Anatomy 2300 who reported their lecture delivery method of choice for Unit III, 21% reported utilizing the face-to-face lectures only, 59% of the total) reported utilizing the online lectures only, and 20% reported utilizing a mixture of both the face-to-face lectures and the online lectures. Finally, for the 44 Pre-Health Sciences majors enrolled in Anatomy 2300 who reported their lecture delivery method of choice for Unit III, 20% reported utilizing the face-to-face lectures only, 59% reported utilizing the online lectures only, and 21% reported utilizing a mixture of both the face-to-face lectures and the online lectures. The contingency table's variables were the three largest majors enrolled in Anatomy 2300 (i.e., Pre-Nursing, Pre-Medicine, and Pre-Health Sciences) and lecture delivery method of choice (i.e., face-to-face only, online only, or a mixture of both) for Unit III. The three largest majors enrolled and their lecture delivery method of choice for Unit III were found to not have a statistically significant relationship [Pearson $\chi^2(4, n = 259) = 4.46$, $p = 0.35$, Cramér's $V = 0.09$].

A two-way contingency table was used to determine whether there was a significant difference between the three largest majors enrolled in the course in their lecture delivery method of choice for Unit IV. Of the 149 Pre-Nursing majors enrolled in Anatomy 2300 who reported their lecture delivery method of choice for Unit IV, 30% reported utilizing the face-to-face lectures only, 48% reported utilizing the online lectures only, and 22% reported utilizing a mixture of both the face-to-face lectures and the online lectures. For the 66 Pre-Medicine majors enrolled in Anatomy 2300 who reported their lecture delivery method of choice for Unit IV, 21% reported utilizing the face-to-face lectures only, 62% reported utilizing the online lectures only, and 17% reported utilizing a mixture of both the face-to-face lectures and the online lectures. Finally, for the 43 Pre-Health Sciences majors enrolled in Anatomy 2300 who reported their lecture delivery method of choice for Unit IV, 21% reported utilizing the face-to-face lectures only, 63% reported utilizing the online lectures only, and 16% reported utilizing a mixture of both the face-to-face lectures and the online lectures. The contingency table's variables were the three largest majors enrolled in Anatomy 2300 (i.e., Pre-Nursing, Pre-Medicine, and Pre-Health Sciences) and lecture delivery method of choice (i.e., face-to-face only, online only, or a mixture of both) for Unit IV. The three largest majors enrolled and their lecture delivery method of choice for Unit IV were found to not have a statistically significant relationship [Pearson $\chi^2(4, n = 259) = 5.53$, $p = 0.24$, Cramér's $V = 0.10$].

Table 38

Preferred Lecture Delivery Method per Curricular Unit of Anatomy 2300 for Pre-Nursing Major Participants

Curricular Unit	Face-to-Face Only	Online Only	Mixture of Both
Unit II – Back & Upper Limb	63	53	33
Unit III – Head & Neck	47	71	42
Unit IV (Thorax, Abdomen, & Pelvis)	25	71	33

This table shows the raw data for the preferred lecture delivery method for Pre-Nursing Anatomy 2300 participants per curricular unit (Unit II n = 149; Unit III n = 150; Unit IV n = 149). Each of the three choices for lecture delivery method are shown.

Table 39

Preferred Lecture Delivery Method per Curricular Unit of Anatomy 2300 for Pre-Medicine Major Participants

Curricular Unit	Face-to-Face Only	Online Only	Mixture of Both
Unit II – Back & Upper Limb	15	35	16
Unit III – Head & Neck	14	39	12
Unit IV – Thorax, Abdomen, & Pelvis	14	41	11

This table shows the raw data for the preferred lecture delivery method for Pre-Medicine Anatomy 2300 participants per curricular unit (Unit II n = 66; Unit III n = 66; Unit IV n = 66). Each of the three choices for lecture delivery method are shown.

Table 40

Preferred Lecture Delivery Method per Curricular Unit of Anatomy 2300 for Pre-Health Science Major Participants

Curricular Unit	Face-to-Face Only	Online Only	Mixture of Both
Unit II – Back & Upper Limb	10	24	10
Unit III – Head & Neck	9	26	9
Unit IV – Thorax, Abdomen, & Pelvis	9	27	7

This table shows the raw data for the preferred lecture delivery method for Pre-Health Science Anatomy 2300 participants per curricular unit (Unit II n = 44; Unit III n = 44; Unit IV n = 43). Each of the three choices for lecture delivery method are shown.

Chapter 5: Discussions

The overall purpose of this research study was to investigate the relationship between learning styles and lecture delivery method of choice of undergraduate anatomy students. Additionally, this study was conducted in order to determine why or how Anatomy is different than other courses in terms of student learning style dimensions as indicated by the Index of Learning Styles (ILS) questionnaire. In this chapter, for each of the research questions, a summary of the study findings will be provided, how those findings supported or did not support the hypotheses made, how the results relate to prior research, how the results contribute to the understanding of learning styles and lecture delivery method of choice, study limitations, and/or practical implications for the undergraduate gross anatomy curriculum due to the research findings. The final portion of the chapter will discuss some areas for future research and implications for instructors, administrators, and students to further the understanding of learning styles and lecture delivery method of choice and their influence at all curricular levels of anatomy curriculum.

Question 1: What is the predominant learning style of students in an undergraduate gross anatomy course?

The results of this study revealed the frequencies of all the respective dimensions for the Anatomy 2300 course. These frequencies indicated the dominant learning styles

of the students in an undergraduate anatomy course were the active, sensing, visual, and sequential dimensions. These results suggest that Anatomy students also have the predominate learning style dimensions that are seen in students in other academic fields. This is not unexpected as Anatomy is a hands-on, concrete science which requires perceiving structures in three-dimensions while building knowledge in a step-wise fashion similar to some of the other STEM curricula.

Although there has been no prior research utilizing the ILS questionnaire in anatomy courses at any curricular levels, the finding of the preferred learning styles of the students enrolled in Anatomy 2300 (i.e., active, sensing, visual, and sequential) is similar to previous findings in other science, technology, engineering, and math (STEM) disciplines. There have been numerous studies utilizing the ILS questionnaire in different engineering fields such as materials (Constant, 1999), environmental (Paterson, 1999), electrical (Kuri & Truzzi, 2002; Zywno & Waalen, 2001; Zywno, 2002), manufacturing (Seery, Gaughran, & Waldmann, 2003), chemical (Montgomery, 1995), civil (Kuri & Truzzi, 2002), mechanical (Kuri & Truzzi, 2002), and industrial (Kuri & Truzzi, 2002), where all the investigators found the preferred learning styles to be the same in all four dimensions (i.e., active, sensing, visual, and sequential) as was found in the current study on students enrolled in anatomy. In fields outside of engineering, such as business (De Vita, 2001), biology (Buxeda & Moore, 1999), and health sciences (Brown, Zoghi, Williams, Jaberzadeh, Roller, Palermo, McKeena, Wright, Baird, Schneider-Kolsky, Hewitt, Sim, & Holt, 2009), the results indicated that the active, sensing, visual, and sequential dimensions were the preferred learning styles.

The findings of this study lend more validity and reliability to the ILS questionnaire and show its usefulness within a broad range of academic fields, including anatomy. Future research is planned to utilize the ILS questionnaire in Anatomy 2300, as well as other anatomy courses from undergraduate to professional levels. Test-retest studies with Anatomy 2300 will be conducted to ensure the validity and reliability of the instrument. Additionally, it is the plan of the researcher that the ILS questionnaire will be utilized as a regular course component to be conducted during the first week of each semester to inform the younger students (i.e., predominately freshman and sophomores) in the course about their learning style dimensions. This is information the students can use to aid in developing their study skills for the Anatomy 2300 course, as well as other courses throughout their collegiate career.

Question 2: What is the predominant learning style of students within particular majors/programs that are registered for an undergraduate gross anatomy course?

In order to determine a learning style profile for the different majors/programs enrolled in the Anatomy 2300 course, the demographics survey included an item that permitted the participant to report their major/program. The majors/programs enrolled in the course were highly variable and ranged from numerous health-related programs to undeclared majors. A list of all the majors in the course is located in Appendix H. The results of the study indicated that although the majority of majors did prefer the active, sensing, visual, and sequential learning style dimensions. There was some variability within certain majors (i.e., Pre-Exercise Science, Pre-Medicine, Biochemistry, Biology, Pharmacy, Neuroscience, Pre-Pharmacy, and Public Health) where students were

reflective learners instead of active learners. This may be an artificial finding for Pre-Exercise Science (n = 12), Biochemistry (n = 2), Biology (n = 8), Neuroscience (n = 7), Pre-Pharmacy (n = 3), and Public Health (n = 2), as the population within these majors was small. However, Pre-Medicine (n = 72) and Pharmacy (n = 21), which had higher enrolled students, may be an actual difference. This difference would make sense because these majors rely on learning pathways and chemical processes, which require the ability to think about the far-reaching scope of the information they are learning. In terms of anatomy, these students would be more interested in the functionality of all the parts of the human body together.

Although there has not been extensive research looking at the preferred learning styles of particular majors utilizing the ILS questionnaire, there are some studies which look at particular student programs including health sciences, natural sciences, and social sciences. The findings of this research are similar to these previous studies and also expands on these previous studies. In a study conducted by Brown *et al.* (2009), the preferred learning styles of health science students, which included occupational therapy, physiotherapy, paramedics, social work, nutrition & dietetics, pharmacy, radiation therapy, radiography, nursing, and midwifery, was found to be active, sensing, visual, and sequential. This study, however, did not expand the research to look at each of the individual majors and instead lumped all the students into a larger group called 'health sciences'. In another study, this one by Ültanir, Ültanir, & Örekeci-Temel (2012), researchers looked at the preferred learning styles of natural science, health science, and social science students. Results indicated that natural science students were active,

sensing, visual, and sequential learners, with a strong emphasis on the visual dimension; health science students were active, sensing, verbal, and sequential learners; and social science students were active, sensing, visual, and sequential learners. It should be noted again that these previous studies did not look at individual majors and instead lumped majors into these three broad categories.

This current study provides information that could be useful in for students to identify their own learning style profile. For example, if students are having a tough time studying or not performing to their expectations in a course, knowing their learning style and understanding the ways in which to approach the material based on that learning style could help students to modify their study habits in order to maximize study time. This current study also provides information that could be useful for advisors and instructors to identify non-traditional students, meaning those students who do not match the preferred learning styles. Advisors, as well as instructors, can utilize these learning style profiles to gain a better understanding of their students. With these profiles, advisors and instructors, can gain a broad viewpoint on what type of students enroll in the course or apply for/get accepted to particular programs. Understanding the students an instructor is working with is important in maximizing the effectiveness in a course. Future research is planned to continue to add to these learning style profiles based on programs/majors and present them to the advisors in the different majors/programs in order to assist them to better understand their students.

Question 3: Are there gender differences in preferred learning styles in an undergraduate gross anatomy course?

Two-way contingency tables were used to determine if there were gender differences in the learning style dimensions of undergraduate anatomy students. The two-way contingency tables for the sensing/intuitive, visual/verbal, and sequential/global dimensions indicated that no statistically significant difference existed between the female and male students. However, the two-way contingency table for the active/reflective dimension indicated that a statistically significant difference did exist between the female and male undergraduate anatomy students with females preferring an active learning style and males preferring a reflective learning style. It is speculated that the results of this study were found because, in the experience of the researcher through meeting with students and talking about study habits, more females enrolled in anatomy would talk about enjoying studying in groups while their male counterparts would typically talk about studying alone and did not like to study in groups (i.e., the definition of both sub-dimensions of the active/reflective dimension). This also may play out in the laboratory component of the anatomy course as the anatomy laboratory is very hands-on with students working with cadavers, models, bones, etc.

The results of the current study indicated that only the active/reflective dimension was statistically significant different between the two genders contrasts previous studies that have found that active/reflective was the only dimension not showing a difference. Litzinger, Lee, Wise, and Felder (2005) showed that there are gender differences for three of the four learning style dimensions in engineering students. They showed that female

engineering students are on average more sequential, more sensing, and less visual than male students. The researchers did not find a gender difference in regards to the active/reflective dimension, a difference that was found in this current study. Another study, this time looking at a random sample of students enrolled at the University of Bahrain within different academic colleges (e.g., College of Arts, Colleges of Business Administration, College of IT, College of Law, College of Engineering, College of Education, and College of Science) and their preferred learning styles, indicated gender differences, in which males were more intuitive learners while females were sensing learners (Alumran, 2008).

In order to gain more evidence into why females are active learners and males are reflective learners, future studies will look at the laboratory component to see how the genders conduct themselves. Future research investigating the relationship between gender and learning style will also aim at increasing the number of males participating in the study. There currently is a drastic difference between the number of males and females enrolled in Anatomy 2300. The lack of males participating in the study was a study limitation and may have resulted in the lack of statistical findings. Results of these studies once again aim at providing a more robust learning style profile of students. If there are gender differences then once again instructors and advisors can be equipped with this information in order to better serve their students.

Question 4: Is there a difference in lecture delivery method between the three respective units?

The results of this study indicated that for all three units the most commonly chosen lecture delivery method was the online only method, followed by face-to-face only and lastly the mixture of both online and face-to-face. For Unit II, the distribution of students for the three different lecture delivery methods was fairly close, however, as the semester progressed the numbers began to skew more towards the online only method. These results may be because of the time the course was offered during the semester, students determining they liked one lecture delivery over the other as the course progressed, and/or weather related (e.g., Spring 2015 had many freezing mornings, snow, and rain; all reasons students have stated why they do not attend class). However, these comparisons were determined to not be significant. These results suggest that anatomy students also preferred the face-to-face delivery method when learning muscle and bone but tended to diverge more to the online method as the subsequent units focused different, and sometimes more complex, content.

There has been a vast amount of research (Driscoll, Jicha, Hunt, Tichavsky, & Thompson, 2012; Euzent, Martin, Moskal, & Moskal, 2011; Rabe-Hemp, Woollen, & Humiston, 2009; Suanpang, Petocz, & Kalceff, 2004) focusing on comparing student engagement, performance, attitudes, and satisfaction within the different lecture delivery methods (i.e. online, face-to-face, and blended), but none of this research is within the realm of undergraduate anatomy courses. However, as the researchers, Klaus and Changchit (2009) have stated "it has become more apparent in higher education

institutions that all classes are not as adaptive to an online format as others" (p.15). It is imperative to understand the mechanics and the student population associated with different courses. In previous studies of online versus face-to-face courses, varied results have indicated that course characteristics such as availability (including semesters offered, time of day offered, etc.), enrollment size, and choice of lecture delivery method for a particular course determine a student's preference for a particular lecture delivery method (Klaus & Changchit, 2009). In this study , the researchers indicated that students preferred the online lecture delivery method for courses which were primarily set-up as a lecture-based class, while non-lecture based courses (e.g., a hands-on laboratory) were preferred as a traditional face-to-face lecture delivery style.

This research suggests that course criteria and content can impact student preference for lecture delivery method. As enrollment sizes increase and universities look to expand online course offerings (especially in regards to the anatomical sciences), it is imperative that course characteristics are taken into account. As anatomy is typically instructed in both a lecture-based and a non-lecture based format, it is important to understand the characteristics that drive students to choose one lecture format over another for different anatomical content areas. In order to increase the usefulness of this research, it is necessary to include some qualitative data from students who are currently completing or have completed the course as to why they chose or did not choose a particular format. This qualitative data will add considerably to our understanding of the quantitative data. In order to validate the data for student attendance to the different lecture delivery methods, future research could utilize clickers, online check-in, etc.

Another avenue for future research will examine different delivery methods for the laboratory component of anatomy and look at the effectiveness of these different methods.

Question 5: Does a student's preferred learning style predict academic achievement per respective unit within an undergraduate gross anatomy course, when controlling for academic ability?

To investigate a possible relationship between preferred learning style and academic achievement in an undergraduate anatomy course, multiple linear regression analyses were conducted where academic ability (defined as the highest ACT composite score) was controlled. Results indicated that only the analyses for Unit III – Head & Neck were statistically significant. Unit III showed a statistically significant relationship between the active/reflective dimension in predicting examination scores. The results could potentially be because head and neck is one of the most complex content areas in anatomy and students have indicated to instructors, that they are more likely to assimilate the information and passively learn the material instead of immediately jumping into the content. Although these results were statistically significant, the practical significance does not translate as a useful difference between active learners and reflective learners as the difference was only one missed exam question.

There has been ample evidence to indicate that matching teaching styles to student's learning styles can significantly improve academic performance, student attitudes, and student behavior at the primary and secondary school level (Griggs & Dunn, 1984; Smith & Renzulli, 1984) and at the college level (Brown, 1978; Charkins,

O'Toole, & Wetzel, 1985). Although it is important for students to match with instructors with particular teaching styles, it is highly unlikely that this occurs consistently in academia today. If a student is mismatched, it is extremely important to provide those students with tools to aid in their achievement. However, when it comes to learning styles, Felder and Spurlin (2005) include some cautionary guidelines to provide to students for discussing learning styles. These guidelines include, "learning styles are continuous dimensions, not categories; learning styles suggest tendencies and are not predictors; learning styles are preferences and not indicators of strengths and weaknesses; and learning styles are not to be used to label students or campaign for modifying classroom instruction" (p. 104-105).

Future research should investigate if there is a relationship between learning styles and academic achievement with the expansion of looking at between groups and within group analyses. These between group analyses would look at and compare each of the four dimensions to each other while the within group analyses would look at the sub-dimensions and compare academic achievement between each (e.g. academic achievement of active learners vs. reflective learners). The information suggested in this study and in future studies can be useful for anatomy instructors if students ask what they can do to study for the different anatomical content areas. Study tips can be modified if students are studying for more straight-forward topics, such as muscles, or are studying more complex areas, such as the head and neck. To expand the research, it is vital to look at the different units a course includes in an effort to pinpoint potential problem areas for students.

Question 6: Does a student's preferred learning style predict their lecture delivery method in an undergraduate gross anatomy course for each respective unit?

To investigate a possible relationship between preferred learning style and lecture delivery method of choice for Unit II, Unit III, and Unit IV in an undergraduate anatomy course, multinomial logistic regression analyses were conducted. The results indicated that for all the tested units, the sensing/intuitive dimension was statistically significant for each in predicting lecture delivery method of choice. It is important to note that since anatomy is a concrete science with a lot of factual information, this result was not unexpected that this dimension would be involved in the choice for lecture delivery method as 85% of the classes were sensing learners. It is possible that these sensing learners were determining the best way to receive that straight-forward factual knowledge. However, this study did not examine to what degree sensing learners chose a certain format or to what degree intuitive learners chose a format. It will be important to determine this so that online and face-to-face lectures can be designed to meet the needs of that student population.

In the scope of previous research, there is a noticeable lack of studies that investigate whether a relationship exists between learning styles (primarily the dimensions indicated by the ILS questionnaire) and preference of lecture delivery method especially at the undergraduate anatomy level. In a study involving medical students at the Karolinska University Hospital, no supporting evidence was found which indicated that learnings styles (as indicated by the ILS questionnaire) are related to the choice of online ECG programs or blended lecture delivery methods (Nilsson, Östergren, Fors,

Rickenlund, Jorfeldt, Caidahl, & Bolinder, 2012). Cook, Thompson, Thomas, and Thomas (2009) also found no association between ILS scores and online format preferences in medical residents. In a study looking at the use of online study material, not lecture delivery method, osteopathic medical students were investigated to determine if learning styles were related to whether or not a student utilized the online material. In this study, learning styles seemed to be related to the use of online learning materials in which students who were "active and intuitive learners were significantly more likely to use online study materials compared to reflective and sensing learners" (Halbert, Kriebel, Cuzzolino, Coughlin, & Fresa-Dillon, 2011, p. 332).

This research adds a new dimension to the discussion of learning styles and lecture delivery method of choice as there is not much research available at the undergraduate level. Understanding the relationship between learning style and lecture delivery method can aid in the development of different anatomical courses and how to attract specific learners. Having information about potential students in a course allows for the development of new online, face-to-face, and blended courses, along with the modification of current courses

Question 7: Does lecture delivery method predict academic achievement on respective unit assessments in an undergraduate gross anatomy course when controlling for academic ability?

To investigate a possible relationship between lecture delivery method of choice and academic achievement for each of the three exam administrations, multiple linear regression analyses utilizing dummy coding were conducted. The results indicated that

the face-to-face only lecture delivery method was the statistically significant for predicting academic achievement and only for Unit II – Back & Upper Limb and Unit III – Head & Neck. Students who chose the face-to-face lecture delivery method over either the online only method or the mixture of both online and face-to-face methods, for both Unit II and Unit III, had higher mean examination scores. The results may indicate the difference in content, thus the effectiveness of how the student utilized the lecture delivery method. For Unit II students are learning back and upper limb muscles as well as the brachial plexus, which as indicated by previous students, is information that can be fairly straight-forward and not warrant too much discussion and interaction with an instructor. However, for Unit III the content changes to more complex and intricate higher level functions and connections within the brain, which in previous interaction with students has elicited much more discussion and interaction with an instructor during a lecture. On the practical level, the difference for both exams was approximately 5% or two questions which can be the difference between plus or minus in the grade bracket. This can be critical for administrators for student acceptance in programs etc.

The majority of studies that have looked at whether or not there was a relationship between lecture delivery method and academic achievement have only done so with end of a course grades. In a study by Williams, Birch, and Hancock (2012), researchers investigated whether students who utilized online lectures as a substitute for the face-to-face lectures earned higher or lower end of semester grades in comparison to those students who attended to the face-to-face lectures. The researchers found that the students who had higher attendance at lectures had a positive and statistically significant

effect on ultimate performance. The researchers stated that "this effect is fairly linear in nature - the more lectures students went to, the higher their eventual marks were" (p. 210). In terms of the students who utilized the online lectures, the researchers indicated that there were two groups of students, specifically those who used the videos as complements to the lecture and those who substituted the face-to-face lectures with the online lectures. The results of their study showed that students who completely substituted the face-to-face lectures with the online lectures, no matter how often they viewed the online recordings, never made up for the lost points from not attending the lectures in person (i.e., they did not do as well on the examinations as those that attended lecture). Their results suggest that the online lecture recordings are most useful as a complement to attending lectures, rather than as a substitute.

This current study added to the evidence of the effectiveness of the different lecture delivery methods. As some courses continue to provide students the option of choosing a lecture delivery method, it is suggested that instructors need to continue to permit those students to choose. However, this research provides data that for anatomy courses, an instructor can provide information to his/her students about the relationship between different lecture delivery methods and academic achievement. This information is also useful to administrators as courses are getting larger and available instructors, particularly in anatomy, are decreasing. What lecture delivery method is 'best' at least for these large introductory science courses? The jury is still out on that question, but this current research added important information to this debate and future research should be undertaken to provide evidence for curricula development. Future work needs

to quantify how difficult the different units are perceived by the enrolled students. A scale to rank the units can aid in this quantification.

Question 8: Is there a gender difference in lecture delivery method per respective unit in an undergraduate gross anatomy course?

Results of this study indicated that no statistically significant difference existed between the female and male students when it came to lecture delivery method choice in the three different units. These results indicate that gender does not impact lecture delivery method of choice for anatomy courses. There currently is a drastic difference between the number of males and females enrolled in Anatomy 2300. The lack of males participating in the study was a study limitation and may have resulted in the lack of statistical findings.

Previous research studies have looked at lecture delivery method and gender, but not within disciplines that include anatomy. In the published research, there also seems to be conflicting data as some studies found significant gender differences while others did not. This current research indicates that gender does not impact lecture delivery methods in Anatomy. In a study of students completing developmental math courses (i.e., an Intermediate Algebra course at a community college), the researchers showed that for the three different lecture delivery methods, there were significant differences in gender in which the online course had the largest percentages of females over both face-to-face and blended lecture styles (Ashby, Sadera, & McNary, 2011). In a study by Coates, Humphreys, Kane, and Vachris (2004), the researchers did not find any significant gender differences within a principle of economics course.

As the Anatomy 2300 course is predominantly female (77.2%), future research investigating the relationship between gender and lecture delivery method will aim at increasing the number of males participating in the study. Future research should also include some qualitative data from students who are currently completing or have completed the course as to why they chose or did not choose a particular format. This qualitative data will add considerably to our understanding of the quantitative data.

Question 9: Do students in the three largest majors/programs have a difference in lecture delivery method per respective unit?

The results indicated that a statistically significant difference was only in Unit II – Back & Upper Limb between the three majors and lecture delivery method of choice. The results indicated that Pre-Nursing students were more likely than both Pre-Medicine and Pre-Health Science students to choose the face-to-face only lecture delivery method, while Pre-Medicine and Pre-Health Science students were more likely to choose the online only lecture delivery method. However, statistical analysis suggested that these differences were not significant. These results indicated that for students enrolled in anatomy courses, different majors did not impact lecture delivery method of choice.

There is a complete lack of research looking at particular majors/programs and what lecture delivery method of choice these students prefer. All previous research has looked at lecture delivery method in specific courses, such as mathematics (Ashby *et al*., 2011; Cascava, Fogler, Abrams, & Durham, 2008; Suanpang *et al*., 2004) sociology (Driscoll *et al*., 2012) economics (Euzent *et al*., 2011), special education (Thompson,

Klass, & Fulk, 2012), and did not focus on the majors/programs of those students enrolled in the courses.

This research has added a new dimension to the discussion on lecture delivery method by looking at student's majors/programs and which lecture delivery method particular majors, in the case of this study Pre-Nursing, Pre-Medicine, and Pre-Health Sciences, choose. These results can aid in the understanding of how anatomy might be different in terms of lecture delivery methods. Anatomy instructors and university administrators can use this information to look for cutting-edge ways to develop new courses, as well as modify of current courses. For example, an anatomy instructor teaching Pre-Nursing students may want to consider choosing a face-to-face format over an online format.

Study Conclusions and Implications

The overarching goal of this study was to investigate the unique nature of anatomy courses in terms of student learning styles, as indicated by the ILS, and lecture delivery method looking at gender and academic achievement. The major findings of this study are as follows:

- The learning styles of anatomy students indicated that these students have similar learning style preferences as students enrolled in other STEM courses. However, it appears that Pre-Medical and Pharmacy students are more reflective learners.
- It appears that the genders are similar in their preferred learning styles with the exception of the active/reflective dimension, with females more likely to be active learners, while males were more likely to be reflective learners.

- Academic achievement of anatomy students was only impacted by the active/reflective dimension within a complex, content-heavy unit (i.e., Head & Neck).
- Learning styles, particularly the sensing/intuitive dimension, appear to have some influence in choosing different lecture delivery methods within anatomy.
- In terms of lecture delivery method, anatomy students:
    - Showed a preference for the online only format.
    - With particular majors sometimes selected different lecture delivery methods, depending on topic.
    - Chose the same lecture delivery method independent of gender.
    - Who attended the face-to-face lectures scored higher on examinations.

The findings of this study can inform the activities of instructors, students, and administrators involved with anatomy curricula. Consideration for anatomy students:

- Use of the ILS provides them with an understanding of their learning style which they can take and utilize in their anatomy courses as well as in other STEM courses.
- Use of the ILS aids to inform their appropriate study skills and habits for different types of anatomical content realizing as primarily active, sensing, visual, and sequential learners, they should be hands-on, utilize clinical applications for understanding, attend laboratory regularly for the three-dimensional aspect, and outline content material in a logical order.

- If choosing online only lecture delivery methods be sure to manage your time and keep pace with the material

Consideration for anatomy instructors:

- According to the ILS, your anatomy students are likely to be active, sensing, visual, and sequential learners, as such you should be teaching in hands-on manner, provide clinical applications for understanding, utilize figures, models, cadavers to allow for understanding the three-dimensional aspect, and teach in an organized, logical order.
- Remember that not all your anatomy students are not the same, therefore, be aware of different learning styles beyond the predominate styles.
- Be aware that student using online delivery methods may not perform as well as students using face-to-face delivery methods and take part in professional development courses to help develop/modify these online courses for best presentation.

Consideration for administrators:

- Promote the utilization of the ILS in anatomy courses so students can take and use the information not only in their anatomy courses but in other STEM courses as well.
- According to the ILS, realize that anatomy students are likely to be active, sensing, visual, and sequential learners; as such you should provide instructors with resources necessary to address these learning styles including providing environments and resources for hands-on activities.

- Provide professional development courses for instructors to develop/modify anatomy courses for different lecture delivery methods.

In summary, although accounting for learning styles is not a new idea, a better knowledge and understanding of learning styles is becoming more critical as course sizes increase and as technological advances continue to mold the types of students entering postsecondary education. While research in this area continues to grow, faculty members should make great efforts to teach in multiple ways that both reach the greatest extent of students in a given class and challenge all students to grow.

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Appendix A: Consent for Participation for Study

CONSENT FOR PARTICIPATION IN SOCIAL AND BEHAVIORAL RESEARCH

Study Title:	Learning Styles of Undergraduate Students and Its Influence on the Preference of Lecture Delivery Method in a Large Enrollment Undergraduate Gross Anatomy Course
Researchers:	Jennifer M. Burgoon, PhD, Melissa M. Quinn, MS, and Theodore Smith
IRB Protocol Number:	2014E0657
IRB Exemption Date:	12/31/2014

This is a consent form for research participation. It contains important information about this study and what to expect if you decide to participate.

Your participation is voluntary.

Please consider the information carefully. Feel free to ask questions before making your decision whether or not to participate. If you decide to participate, you will be asked to sign this form.

You may leave the study at any time. If you decide to stop participating in the study, there will be no penalty to you, and you will not lose any benefits to which you are otherwise entitled. Your decision will not affect your future relationship with The Ohio State University.

Purpose: To examine the preferred learning styles of undergraduate students enrolled in gross anatomy, the influence of gender on learning styles, the influence of student's majors/programs on learning styles, the influence of learning styles on academic achievement in gross anatomy, the influence of learning styles on lecture delivery method of choice, the influence of gender on lecture delivery method of choice, the influence of a student's major/program on lecture delivery method of choice, and the influence of lecture delivery method of choice on academic achievement in gross anatomy.

Procedures/Tasks: Your participation in this study will be no longer than 10-15 minutes in total. Your time commitment will be associated with the completion of one learning styles questionnaire, at the end of which will also include demographic questions to collect information such as gender, age, major, ethnicity, academic year, number of credits completed, and your intended career after graduation. Additionally, with consent, your ACT or SAT score will be obtained from The Ohio State University's Enrollment Services Office, along with your exam grades on Units II, III, and IV from the Anatomy 2300 *Human Anatomy* course director. Finally, your indication of how you completed the lecture portion of the course (i.e., your primary lecture delivery method of choice) for each unit, will be obtained from the Anatomy 2300 *Human Anatomy* course director.

Confidentiality: The data and results of data analyses will be presented in summative form in any publications and/or reports produced. Your name will not be connected with this study in any way when the results are reported. Additionally, none of the data you provide in the surveys will affect your individual course grades and assessments.

Efforts will be made to keep your study-related information confidential. However, there may be circumstances where this information must be released. For example, personal information regarding your participation in this study may be disclosed if required by state law. Also, your records may be reviewed by the following groups (as applicable to the research):

- Office for Human Research Protections or other federal, state, or international regulatory agencies;
- The Ohio State University Institutional Review Board or Office of Responsible Research Practices;
- The sponsor, if any, or agency (including the Food and Drug Administration for FDA-regulated research) supporting the study.

Risks: This study will take a few minutes of your time, but should be of no risk or cause any discomfort to you.

Benefits: The main benefit from participating in this study will be that those students that complete the learning styles questionnaire will be provided with their individuated results and study strategies based on their particular learning style, which can aid students in academic settings. Additionally, participation has the potential to improve anatomical instruction, learning styles, and lecture delivery methods in an undergraduate anatomy course.

Incentives: In total, eight (8) gift certificates of $25.00 will be raffled off to those students that agree to participate as indicated by the signing of the consent form. The gift certificates will be raffled off at the completion of the Anatomy 2300 *Human Anatomy* course (i.e., at the end of the Spring 2015 semester). Additionally, all students that sign

the consent form and complete the learning styles questionnaire will receive their individualized results with descriptions of learning styles and study strategies based on their learning style.

Participant Rights: You may refuse to participate in this study without penalty or loss of benefits to which you are otherwise entitled. If you are a student or employee at Ohio State, your decision will not affect your grades or employment status.

If you choose to participate in the study, you may discontinue participation at any time without penalty or loss of benefits. By signing this form, you do not give up any personal legal rights you may have as a participant in this study.

This research study has been reviewed and determined exempt by the Office of Responsible Research Practices at OSU.

Contacts and Questions: For questions, concerns, or complaints about the study you may contact Ms. Melissa M. Quinn, Graduate Teaching Associate, Division of Anatomy, at (614) 292-4831.

For questions about your rights as a participant in this study or to discuss other study-related concerns or complaints with someone who is not part of the research team, you may contact Ms. Sandra Meadows in the Office of Responsible Research Practices at 1-800-678-6251.

I have read (or someone has read to me) this form and I am aware that I am being asked to participate in a research study. I have had the opportunity to ask questions and have had them answered to my satisfaction. I voluntarily agree to participate in this study.

I am not giving up any legal rights by signing this form and I was given a copy of this form**.**

By signing this consent form, I consent to the use of my learning styles questionnaire responses, as well as the use of my demographics information. I also consent to the use of my primary lecture delivery method of choice for and my lecture exam scores from Units II, III, and IV of Anatomy 2300 *Human Anatomy*. Finally, I also consent to the use of my ACT or SAT score, which will be obtained from The Ohio State University's Enrollment Services Office.

_____ _____

Signature of Research Participant **Date**

_____ _____

Printed Name of Research Participant **Date**

Printed Name of Person Obtaining Consent	**Signature of Person Obtaining Consent**

Appendix B: Verbal Script for Obtaining Consent

Verbal Script for Recruitment of Potential Participants

Good (morning/afternoon). My name is Melissa Quinn and I am a PhD candidate in the Division of Anatomy in the College of Medicine at The Ohio State University. I am here today to talk to you all about my dissertation study which involves examining the preferred learning styles of undergraduate students enrolled in a gross anatomy course, as well as examining lecture delivery method of choice for this population. Your participation in this study is strictly voluntary. If you would like to participate, please complete the consent form found. If you do consent to this study, I will make a copy of the consent form and provide you with the copy for you to maintain. As an incentive to patriciate, all students that consent to participate will be entered into a drawing to win one of eight $25 gift certificates.

Let's review the consent form now.

This research project was determined exempt by The Ohio State University Office of Responsible Research Practices.

Again, your participation is voluntary.

You will then see that a more thoroughly outlined purpose for the research is available for you to read.

If you agree to participate, what will you be asked to do to participate in this study? Your participation in this study will be no longer than 10-15 minutes in total. Your time commitment will be associated with the completion of one learning styles questionnaire, at the end of which will also include demographic questions to collect information such as gender, age, major, ethnicity, academic year, number of credits completed, and your intended career after graduation. Additionally, with consent, your ACT or SAT score will be obtained from The Ohio State University's Enrollment Services Office, along with your exam grades on Units II, III, and IV from the Anatomy 2300 *Human Anatomy* course director. Finally, your indication of how you completed the lecture portion of the course (i.e., your primary lecture delivery method of choice) for each unit will be obtained from the Anatomy 2300 *Human Anatomy* course director.

The data and results of data analyses will be presented in summative form in any publications and/or reports produced. Your name will not be connected with this study in any way when the results are reported. Additionally, none of the data you provide in the surveys will affect your individual course grades and assessments.

When you complete the learning styles questionnaire today, you will see that it will request your name. This is to tie your responses to your other data, as well as to be able to provide you with your personalized learning style results. However, once all data is collected, it will be placed into a database and the database will be made anonymous (i.e., all names will be removed). After this, then data analyses for this research will begin.

Although efforts will be made to keep your study-related information confidential, there may be circumstances where this information must be released – such as if required by law.

This study will take a few minutes of your time, but should be of no risk or cause any discomfort to you.

So why participate?

The main benefit from participating in this study will be that those students that complete the learning styles questionnaire will be provided with their individuated results and study strategies based on their particular learning style, which can aid students in academic settings. Additionally, participation has the potential to improve anatomical instruction, learning styles, and lecture delivery methods in an undergraduate anatomy course.

What could you and will you receive for your participation?

In total, eight (8) gift certificates of $25.00 will be raffled off to those students that agree to participate as indicated by the signing of the consent form. The gift certificates will be raffled off at the completion of the Anatomy 2300 *Human Anatomy* course (i.e., at the end of the Spring 2015 semester). Additionally, all students that sign the consent form and complete the learning styles questionnaire will receive their individualized results with descriptions of learning styles and study strategies based on their learning style.

You may refuse to participate in this study without penalty or loss of benefits to which you are otherwise entitled. If you are a student or employee at Ohio State, your decision will not affect your grades or employment status.

If you choose to participate in the study, you may discontinue participation at any time without penalty or loss of benefits. By signing this form, you do not give up any personal legal rights you may have as a participant in this study.

Does anyone have any questions concerning this research?

If later, you think of any question(s) you would like to ask, please contact me – my information is available in the consent form.

So – if you are going to consent to participate in this research – please sign your name, print your name, provide your OSU Name.#, and provide today's date. Again, by signing, you are agreeing to the use of your answers to the learning styles questionnaire, your demographic information, and your lecture delivery method and lecture exam scores during Units II, III, and IV, as well as your ACT or SAT scores for this study. You many also consider this participation over the following week and submit your consent form the following laboratory, when I meet with anyone that has missed lab this week. Thank you for your consideration.

I will now collect these signed consent forms (the extra copy is for your own personal records). Again, thank you for your consideration.

I now ask that those agreeing to participate complete the Index of Learning Styles

questionnaire with added demographic questions during the next 10-15 minutes.

Appendix C: Index of Learning Styles Questionnaire

Index of Learning Styles Questionnaire

Name: _____

Directions:
For each of the 44 questions below select either "a" or "b" to indicate your answer. Please choose only one answer for each question. If both "a" and "b" seem to apply to you, choose the one that applies more frequently. Once the scoring of the questionnaire is complete, you will be provided with your preferred learning style as well as information on each type.

1) I understand something better after I
    a. try it out.
    b. think it through.

2) I would rather be considered
    a. realistic.
    b. innovative.

3) When I think about what I did yesterday, I am most likely to get
    a. a picture.
    b. words.

4) I tend to
    a. understand details of a subject but may be fuzzy about its overall structure.
    b. understand the overall structure but may be fuzzy about details.

5) When I am learning something new, it helps me to
    a. talk about it.
    b. think about it.

6) If I were a teacher, I would rather teach a course
    a. that deals with facts and real life situations.
    b. that deals with ideas and theories.

7) I prefer to get new information in

a. pictures, diagrams, graphs, or maps.
b. written directions or verbal information.

8) Once I understand
   a. all the parts, I understand the whole thing.
   b. the whole thing, I see how the parts fit.

9) In a study group working on difficult material, I am more likely to
   a. jump in and contribute ideas.
   b. sit back and listen.

10) I find it easier
   a. to learn facts.
   b. to learn concepts.

11) In a book with lots of pictures and charts, I am likely to
   a. look over the pictures and charts carefully.
   b. focus on the written text.

12) When I solve math problems
   a. I usually work my way to the solutions one step at a time.
   b. I often just see the solutions but then have to struggle to figure out the steps to get to them.

13) In classes I have taken
   a. I have usually gotten to know many of the students.
   b. I have rarely gotten to know many of the students.

14) In reading nonfiction, I prefer
   a. something that teaches me new facts or tells me how to do something.
   b. something that gives me new ideas to think about.

15) I like teachers
   a. who put a lot of diagrams on the board.
   b. who spend a lot of time explaining.

16) When I'm analyzing a story or a novel
   a. I think of the incidents and try to put them together to figure out the themes.
   b. I just know what the themes are when I finish reading and then I have to go back and find the incidents that demonstrate them.

17) When I start a homework problem, I am more likely to
   a. start working on the solution immediately.

b. try to fully understand the problem first.

18) I prefer the idea of
   a. certainty.
   b. theory.
19) I remember best
   a. what I see.
   b. what I hear.

20) It is more important to me that an instructor
   a. lay out the material in clear sequential steps.
   b. give me an overall picture and relate the material to other subjects.

21) I prefer to study
   a. in a study group.
   b. alone.

22) I am more likely to be considered
   a. careful about the details of my work.
   b. creative about how to do my work.

23) When I get directions to a new place, I prefer
   a. a map.
   b. written instructions.

24) I learn
   a. at a fairly regular pace. If I study hard, I'll "get it."
   b. in fits and starts. I'll be totally confused and then suddenly it all "clicks."

25) I would rather first
   a. try things out.
   b. think about how I'm going to do it.

26) When I am reading for enjoyment, I like writers to
   a. clearly say what they mean.
   b. say things in creative, interesting ways.

27) When I see a diagram or sketch in class, I am most likely to remember
   a. the picture.
   b. what the instructor said about it.

28) When considering a body of information, I am more likely to
   a. focus on details and miss the big picture.

b. try to understand the big picture before getting into the details.

29) I more easily remember
   a. something I have done.
   b. something I have thought a lot about.

30) When I have to perform a task, I prefer to
   a. master one way of doing it.
   b. come up with new ways of doing it.

31) When someone is showing me data, I prefer
   a. charts or graphs.
   b. text summarizing the results.

32) When writing a paper, I am more likely to
   a. work on (think about or write) the beginning of the paper and progress forward.
   b. work on (think about or write) different parts of the paper and then order them.

33) When I have to work on a group project, I first want to
   a. have "group brainstorming" where everyone contributes ideas.
   b. brainstorm individually and then come together as a group to compare ideas.

34) I consider it higher praise to call someone
   a. sensible.
   b. imaginative.

35) When I meet people at a party, I am more likely to remember
   a. what they looked like.
   b. what they said about themselves.

36) When I am learning a new subject, I prefer to
   a. stay focused on that subject, learning as much about it as I can.
   b. try to make connections between that subject and related subjects.

37) I am more likely to be considered
   a. outgoing.
   b. reserved.

38) I prefer courses that emphasize
   a. concrete material (facts, data).

b. abstract material (concepts, theories).

39) For entertainment, I would rather
    a. watch television.
    b. read a book.

40) Some teachers start their lectures with an outline of what they will cover. Such outlines are
    a. somewhat helpful to me.
    b. very helpful to me.

41) The idea of doing homework in groups, with one grade for the entire group,
    a. appeals to me.
    b. does not appeal to me.

42) When I am doing long calculations,
    a. I tend to repeat all my steps and check my work carefully.
    b. I find checking my work tiresome and have to force myself to do it.

43) I tend to picture places I have been
    a. easily and fairly accurately.
    b. with difficulty and without much detail.

44) When solving problems in a group, I would be more likely to
    a. think of the steps in the solution process.
    b. think of possible consequences or applications of the solution in a wide range of areas.

Appendix D: Demographics Survey

What is your gender?

A. Female
B. Male

Please fill-in your birthdate: _____.

To which racial or ethnic group do you identify?

A. African-American (non-Hispanic)
B. American Indian or Aleut
C. Asian/Pacific Islanders
D. Caucasian (non-Hispanic)
E. Latino or Hispanic
F. Other

Please indicate which Anatomy 2300 section you are registered for this semester.

A. 2300.01
B. 2300.02
C. 2300.03
D. 2300.04

Please indicate your current academic year within the university.

A. Freshman
B. Sophomore
C. Junior
D. Senior
E. Other (ex. continuing education, graduate student, etc.)

Are you an international student?

A. Yes
B. No

What is the number of undergraduate credits you have completed so far (i.e., at the start of the spring 2015 semester)?

A. 0 – 29 credits
B. 30 – 59 credits
C. 60 – 89 credits

D. 90 – up credits

Please indicate your declared major? (Note: If your major is not listed, for letter "I" please write-in your major OR if you have not declared a major, for letter "I" please write in "Undeclared").

A. Athletic training
B. Exercise science
C. Health science
D. Pre-dental hygiene
E. Pre-medicine
F. Pre-nursing
G. Radiologic sciences and therapy
H. Respiratory therapy
I. Other:_____

Please fill-in your intended profession (i.e. job) after graduation? (i.e., Dentist, Doctor, Physical Therapist, etc.)

_____

Appendix E: Index of Learning Styles Result Sheet

Results of the Index of Learning Styles Questionnaire

NAME:_____

```
ACT                                                     REF
          11  9   7   5   3   1   1   3   5   7   9   11
                          <-- -->

SEN                                                     INT
          11  9   7   5   3   1   1   3   5   7   9   11
                          <-- -->

VIS                                                     VRB
          11  9   7   5   3   1   1   3   5   7   9   11
                          <-- -->

SEQ                                                     GLO
          11  9   7   5   3   1   1   3   5   7   9   11
                          <-- -->
```

- If your score on a scale is 1-3, you are fairly well balanced on the two dimensions of that scale.
- If your score on a scale is 5 or 7, you have a moderate preference for one dimension of the scale and will learn more easily in a teaching environment which favors that dimension.
- If your score on a scale is 9 or 11, you have a very strong preference for one dimension of the scale. You may have real difficulty learning in an environment which does not support that preference

Appendix F: Descriptions of Learning Styles and Study Strategies

LEARNING STYLES AND STRATEGIES

ACTIVE AND REFLECTIVE LEARNERS

- Active learners tend to retain and understand information best by doing something active with it--discussing or applying it or explaining it to others. Reflective learners prefer to think about it quietly first.
- "Let's try it out and see how it works" is an active learner's phrase; "Let's think it through first" is the reflective learner's response.
- Active learners tend to like group work more than reflective learners, who prefer working alone.
- Sitting through lectures without getting to do anything physical but take notes is hard for both learning types, but particularly hard for active learners.

Everybody is active sometimes and reflective sometimes. Your preference for one category or the other may be strong, moderate, or mild. A balance of the two is desirable. If you always act before reflecting you can jump into things prematurely and get into trouble, while if you spend too much time reflecting you may never get anything done.

How can active learners help themselves?

If you are an active learner in a class that allows little or no class time for discussion or problem-solving activities, you should try to compensate for these lacks when you study. Study in a group in which the members take turns explaining different topics to each other. Work with others to guess what you will be asked on the next test and figure out how you will answer. You will always retain information better if you find ways to do something with it.

How can reflective learners help themselves?

If you are a reflective learner in a class that allows little or no class time for thinking about new information, you should try to compensate for this lack when you study. Don't simply read or memorize the material; stop periodically to review what you have read and to think of possible questions or applications. You might find it helpful to write short summaries of readings or class notes in your own words. Doing so may take extra time but will enable you to retain the material more effectively.

SENSING AND INTUITIVE LEARNERS

- Sensing learners tend to like learning facts, intuitive learners often prefer discovering possibilities and relationships.
- Sensors often like solving problems by well-established methods and dislike complications and surprises; intuitors like innovation and dislike repetition. Sensors are more likely than intuitors to resent being tested on material that has not been explicitly covered in class.
- Sensors tend to be patient with details and good at memorizing facts and doing hands-on (laboratory) work; intuitors may be better at grasping new concepts and are often more comfortable than sensors with abstractions and mathematical formulations.
- Sensors tend to be more practical and careful than intuitors; intuitors tend to work faster and to be more innovative than sensors.
- Sensors don't like courses that have no apparent connection to the real world; intuitors don't like "plug-and-chug" courses that involve a lot of memorization and routine calculations.

Everybody is sensing sometimes and intuitive sometimes. Your preference for one or the other may be strong, moderate, or mild. To be effective as a learner and problem solver, you need to be able to function both ways. If you overemphasize intuition, you may miss important details or make careless mistakes in calculations or hands-on work; if you overemphasize sensing, you may rely too much on memorization and familiar methods and not concentrate enough on understanding and innovative thinking.

How can sensing learners help themselves?

Sensors remember and understand information best if they can see how it connects to the real world. If you are in a class where most of the material is abstract and theoretical, you may have difficulty. Ask your instructor for specific examples of concepts and procedures, and find out how the concepts apply in practice. If the teacher does not provide enough specifics, try to find some in your course text or other references or by brainstorming with friends or classmates.

How can intuitive learners help themselves?

Many college lecture classes are aimed at intuitors. However, if you are an intuitor and you happen to be in a class that deals primarily with memorization and rote substitution in formulas, you may have trouble with boredom. Ask your instructor for interpretations or theories that link the facts, or try to find the connections yourself. You may also be prone to careless mistakes on test because you are impatient with details and don't like repetition (as in checking your completed solutions). Take time to read the entire question before you start answering and be sure to check your results

VISUAL AND VERBAL LEARNERS

Visual learners remember best what they see--pictures, diagrams, flow charts, time lines, films, and demonstrations. Verbal learners get more out of words--written and spoken explanations. Everyone learns more when information is presented both visually and verbally.

In most college classes very little visual information is presented: students mainly listen to lectures and read material written on chalkboards and in textbooks and handouts. Unfortunately, most people are visual learners, which means that most students do not get nearly as much as they would if more visual presentation were used in class. Good learners are capable of processing information presented either visually or verbally.

How can visual learners help themselves?

If you are a visual learner, try to find diagrams, sketches, schematics, photographs, flow charts, or any other visual representation of course material that is predominantly verbal. Ask your instructor, consult reference books, and see if any videotapes or CD-ROM displays of the course material are available. Prepare a concept map by listing key points, enclosing them in boxes or circles, and drawing lines with arrows between concepts to show connections. Color-code your notes with a highlighter so that everything relating to one topic is the same color.

How can verbal learners help themselves?

Write summaries or outlines of course material in your own words. Working in groups can be particularly effective: you gain understanding of material by hearing classmates' explanations and you learn even more when you do the explaining.

SEQUENTIAL AND GLOBAL LEARNERS

- Sequential learners tend to gain understanding in linear steps, with each step following logically from the previous one. Global learners tend to learn in large jumps, absorbing material almost randomly without seeing connections, and then suddenly "getting it."
- Sequential learners tend to follow logical stepwise paths in finding solutions; global learners may be able to solve complex problems quickly or put things together in novel ways once they have grasped the big picture, but they may have difficulty explaining how they did it.

Many people who read this description may conclude incorrectly that they are global, since everyone has experienced bewilderment followed by a sudden flash of understanding. What makes you global or not is what happens before the light bulb goes on. Sequential learners may not fully understand the material but they can nevertheless do

something with it (like solve the homework problems or pass the test) since the pieces they have absorbed are logically connected. Strongly global learners who lack good sequential thinking abilities, on the other hand, may have serious difficulties until they have the big picture. Even after they have it, they may be fuzzy about the details of the subject, while sequential learners may know a lot about specific aspects of a subject but may have trouble relating them to different aspects of the same subject or to different subjects.

How can sequential learners help themselves?

Most college courses are taught in a sequential manner. However, if you are a sequential learner and you have an instructor who jumps around from topic to topic or skips steps, you may have difficulty following and remembering. Ask the instructor to fill in the skipped steps, or fill them in yourself by consulting references. When you are studying, take the time to outline the lecture material for yourself in logical order. In the long run doing so will save you time. You might also try to strengthen your global thinking skills by relating each new topic you study to things you already know. The more you can do so, the deeper your understanding of the topic is likely to be.

How can global learners help themselves?

If you are a global learner, it can be helpful for you to realize that you need the big picture of a subject before you can master details. If your instructor plunges directly into new topics without bothering to explain how they relate to what you already know, it can cause problems for you. Fortunately, there are steps you can take that may help you get the big picture more rapidly. Before you begin to study the first section of a chapter in a text, skim through the entire chapter to get an overview. Doing so may be time-consuming initially but it may save you from going over and over individual parts later. Instead of spending a short time on every subject every night, you might find it more productive to immerse yourself in individual subjects for large blocks. Try to relate the subject to things you already know, either by asking the instructor to help you see connections or by consulting references. Above all, don't lose faith in yourself; you will eventually understand the new material, and once you do your understanding of how it connects to other topics and disciplines may enable you to apply it in ways that most sequential thinkers would never dream of.

Appendix G: Index of Learning Styles Score Sheet

Index of Learning Styles Scoring

1. Put "1"s in the appropriate spaces in the table below (e.g. if you answered "a" to Question 3, put a "1" in Column A by Question 3; if you answered "b" to Question 32 put a "1" in Column B by Question 32).
2. Total the columns and write the totals in the indicated spaces.
3. For each of the four scales, subtract the smaller total from the larger one. Write the difference (1 to 11) and the letter (a or b) for which the total was larger on the bottom line. For example, if under "ACT/REF" you had 4 "a" and 7 "b" responses, you would write "3b" on the bottom line under that heading.

ACT/REF			**SNS/INT**			**VIS/VRB**			**SEQ/GLO**		
Q	a	b	Q	a	b	Q	a	b	Q	a	b
1			2			3			4		
5			6			7			8		
9			10			11			12		
13			14			15			16		
17			18			19			20		
21			22			23			24		
25			26			27			28		
29			30			31			32		
33			34			35			36		
37			38			39			40		
41			42			43			44		
Total (sum X's in each column)											
ACT/REF			**SNS/INT**			**VIS/VRB**			**SEQ/GLO**		
a	**b**		**a**	**b**		**a**	**b**		**a**	**b**	
(Larger – Smaller) + Letter of Larger (see below*)											

*Example: If you totaled 3 for "a" and 8 for "b", you would enter "5b" in the appropriate space.

Appendix H: List of All Reported Majors/Programs Enrolled in Anatomy 2300 during Spring 2015

Pre-Athletic Training
Pre-Exercise Science
Pre-Health Science
Pre-Dental Hygiene
Pre-Medicine
Pre-Nursing
Pre-Radiologic Sciences & Therapy
Respiratory Science
Animal Science
Biochemistry
Biology
Bachelor of Science in Pharmaceutical Sciences (BSPS)*
Chemical Engineering
Chemistry
Continuing Education
Dietetics
Engineering
Exploration
Genetics
Graduate Entry Nurse Practitioner
HDFS (Human Development and Family Science)
Health Explorations
Pre-Health Information Management & Systems (HIMS)
Health Promotion, Nutrition & Exercise Science (HPNES)
Human Nutrition
Japanese
Medical Dietetics
Neuroscience
Pharmacy
Political Science
Pre-Dental
Pre-Dietetic
Pre-Optometry
Pre-Pharmacy
Pre-Vet

Psychology
Public Health
Sociology
Speech and Hearing Science
Undeclared
Zoology