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Examining the Usefulness of Cadavers in Human Anatomy Classes:

A Student's Perspective

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By

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Examining the Usefulness of Cadavers in Human Anatomy Classes

– A Student's Perspective

A THESIS

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ABSTRACT OF THESIS

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ABSTRACT: Students have not been involved in the decision to use cadavers in undergraduate-level gross human anatomy classes. This study examines five different aspects (learning, pathology appreciation, emotional impact, safety, and healthcare profession) of the learning experience, investigating opinions regarding the usefulness of cadavers from students enrolled in cadaver and non-cadaver based courses in Oklahoma City metropolitan area institutions. A Likert Scale conversion was applied to 12 statements to form a score reflecting the level of positive opinion on usefulness of cadavers in human anatomy courses. For five statements the opinion of students from both cadaver and non-cadaver courses reflected a positive view of cadaver usefulness. For five statements the students of cadaver courses had significantly more positive opinions of cadaver use than students of non-cadaver courses. The other two statements reflected a less positive view of cadaver usefulness from both groups of students.

INTRODUCTION

The instruction of human anatomy at the university level commonly, but not always, involves the use of cadavers. The decision to include cadavers is made at an institutional level by the dean of the college, head of the department and/or instructors, and involves the consideration of several factors such as costs, regulations, and availability of alternatives to cadavers. Students have not been a part of this decision. A literature review revealed that opinions of undergraduate students regarding the usefulness of cadavers have never been elicited. Prior studies that have reported on student opinions examined the retention of material learned in human anatomy courses (Hasan, *et al.*, 2011), if assessment strategies were being developed (Sawant, 2015), or if preferences were being sought for the use of cadavers versus new technologies (Hasan, *et al*., 2011). Opinions of undergraduate students have also been sought when determining whether or not the use of cadavers contributed to effective learning experiences based on the qualities of dissections performed by the students (Kraszpulska, *et al.*, 2013), and in determining student preferences towards the use of cadavers versus other mammals (Shoepe, 2008). There are no peer-reviewed articles that dealt specifically with how students perceive the usefulness of cadavers in their anatomy classroom. In other words, do students consider the use of human cadavers a vital or dispensable link to their education?

In this study a questionnaire was presented to a sampling of students who were in the final stages of a gross (meaning to focus on structures, organs, muscles, bones, etc., which are visible to the naked eye) human anatomy course or had recently completed a course in human anatomy. These students were enrolled in human anatomy courses in

institutions of higher education located within the Oklahoma City metropolitan area. Some institutions used cadavers and models, one used mammals and models, whereas others used only models. The data collection instrument gathered ranked options about student opinions regarding cadaver use. Results from this study may help universities understand student perspectives of the usefulness of human cadavers and might provide meaningful insights when considering whether cadavers will be used or not in human anatomy courses.

History of Human Cadaver Use

The study of human anatomy is necessary for entrance into a field of medicine. Early anatomists created empirical drawings from what they had witnessed within the cadaveric remains of executed prisoners. As the need for human cadavers grew, obtaining specimens eventually became synonymous with body snatching and other unethical means. Cadavers were dissected with medical intent prior to 200 BCE by Greek physicians, Herophilos and Erasistratos (nicknamed “the Butchers of Alexandria”). These two physicians routinely performed dissections and possibly vivisections to prove and disprove accepted misconceptions about the human body until Christians and the popular opinion of society deemed their practices unholy and unnecessary (Bay and Bay, 2010). The concept of dissection for acquiring knowledge about the structures of the human body was started in the 15th century, as barber surgeons (medical practitioners of Medieval Europe) used human cadavers to demonstrate various structures at the professors command (Rath and Garg, 2006). Following the Anatomy Act of 1832 in Britain (which gave anatomists legal access to unclaimed bodies), U.S. states began to

pass legislation allowing the legal procurement of bodies for medical study (Hulkower, 2011). The regulated use of cadavers by Oklahoma colleges and universities became available in 1935, when the Oklahoma State legislature approved the establishment of The Anatomical Board of the State of Oklahoma. The function of the board was to provide for the collection, preservation, storage, distribution, delivery, recovery for users, cremation, and final disposition of all dead human bodies used for health science education and research in the state (State of Oklahoma Anatomical Board, 2014).

In Oklahoma, 21 of the 53 colleges and universities are currently approved to receive cadavers (State of Oklahoma Anatomical Board, 2014). Included in the schools that receive cadavers are Oklahoma's two accredited MD-granting institutions. Additionally, of the 25 colleges and universities in Oklahoma City and the surrounding suburbs, only seven use cadavers in the teaching of human anatomy.

Until the fall semester of 1997 the Department of Biology at the University of Central Oklahoma used mink and cats as dissection specimens. These were liberally supplanted with human anatomical models and real bone skeletal materials. However, Dr. William Radke, who was the instructor of record for anatomy courses taught in the Department of Biology, switched to cadaver use in 1997 based on his belief that though mammalian systems are similar from species to species, nothing drives home the anatomical relationships and systems structure like having human cadavers (Radke, 2014).

Problems Using Human Cadavers

There are several problems to using cadavers. One is the costs associated with having a cadaver lab. Because cadavers cannot be bought or sold, the Oklahoma Willed Body Program (under the auspices of the State of Oklahoma Anatomical Board) charges fees for the usage of the cadavers. Today's cost to secure a single cadaver for one semester is $1505.00 (State of Oklahoma Anatomical Board, 2014). The fee charged for this service is a prohibitive factor to some institutions of higher education. Cadavers present institutions with ongoing costs that include: facilities (special air conditioning and ventilation considerations are required to maintain cadavers), chemicals (those initially used in the embalming process and additional chemicals required to preserve specimens for the entirety of a school term), security (precautions must be continually taken to ensure the secure storage of the cadavers), equipment (special containers used for maintenance and proper storage of dissections; dissection tools such as Stryker saws and miscellaneous stainless steel hand tools), and personnel (specially trained and board approved employees are the only school members allowed to safely handle cadavers). Staff must be refreshed periodically on the safe handling, storage, and disposal of such hazardous materials. Of the costs associated with cadavers, the continual maintenance of facilities is the largest burden schools encounter. Schools that do not have existing facilities can expect upgrade costs up to and often exceeding $1 million, depending on the number of cadavers to be used.

Another problem is the concern of hazardous chemicals that are associated with the use of human cadavers. The chemicals used to preserve cadavers include formaldehyde, phenol, methyl alcohol, and glycerin. Embalming solutions made from

combinations of these chemicals are used to preserve tissue and eliminate infectious agents. Although embalming chemicals destroy most infectious agents some agents remain and result in irritation to the integumentary, respiratory, and nervous systems. However, most cadavers will have been screened for diseases at the time of death or during the embalming process, and therefore are of low risk for infections (State of Oklahoma Anatomical Board, 2014). These chemicals carry health risks that are deterrents to some schools for the changeover to cadaver-taught human anatomy. Research has shown that formaldehyde is a noxious chemical that produces unpleasant smells, causes runny or congested nose, redness of eyes, and skin-related diseases. Formaldehyde may also decrease assimilation of knowledge by students during anatomy dissection (Onyije and Avwioro, 2012). According to the U.S. Environmental Protection Agency (EPA), formaldehyde is classified as a probable human carcinogen, and the International Agency for Research on Cancer (IARC) classifies formaldehyde as a human carcinogen (National Cancer Institute, 2011).

Another problem is that some states have reported a shortage of willed bodies, causing a shortage of available cadavers (Anteby, 2009). When the number of cadaver donations to "willed body programs" does not meet the needs for all the schools requesting bodies, the medical schools will be the first to be supplied. The remaining bodies are purchased from other body programs out of state (The State of Oklahoma Anatomical Board, 2014). Cadaver donations can be affected by religious views, culture, ignorance, and love even after death (Bari, *et al.*, 2012). A shortage of cadavers may force non-medical school institutions to use alternative means of instruction. Because of the fact that normally there is considerable variation possible with certain aspects of

human anatomy (for example, blood vessel distribution) there may be difficulty in finding a cadaver that can be considered typical (Kulkarni, 2013).

Other concerns expressed in the recent literature points to the question of the usefulness of cadaver dissections (Guttmann, *et al.*, 2004; McLachlan, 2004). Cadaver training is seen by some institutions as being a socialization tool that assists students in experiencing and coping with the body and mortality (Robbins, *et al*., 2008). Other studies concluded that some students sense a profound psychological impact due to the exposure to human cadavers (Hancock, *et al.*, 2004; Kahn and Mirza, 2013). One study concluded that human cadaver experience is just a psychological bridge that must be crossed to become a doctor (Giegerich, 2002), whereas another study viewed cadaver experience as an emotional socialization for students (Hafferty, 1988). The most common coping mechanism found by researchers (for dealing with human cadavers) was students sharing experiences and emotions to family and friends (O'Carroll, *et al.*, 2002). Intellectual detachment can occur if coping mechanisms are avoided (Charlton, *et al.*, 1994). There is research indicating the need for inclusion of courses to help students manage their emotions when experiencing cadavers (Marks, *et al.*, 1997). The emotional aspect of cadaver usage is included in this study.

Alternatives to Human Cadavers

Generally, human anatomy labs use cadavers, models, and/or animal specimens as instructional tools. Instead of cadavers, some schools use less regulated, budget-friendly alternatives. These choices may include preserved mammal specimens, plastic models, or

even plastinated human specimens or various human structures that have been plastinated. All are activities requiring hands-on student participation. Non-hands-on sources include DVDs, internet web sites, 3-D applications (apps), and 3-D imaging technology. In 2004, the approximate number of students who used personal computers was about 95%, with their primary use in anatomy classes as a means to find relevant material for exam preparation (Jastrow and Hollinderbäumer, 2004). Today's percentage of university students having access to online resources is anticipated to be closer to 100%. Students can go online to access interactive human anatomy websites to complete lab assignments, allowing computer-aided manipulations of all areas of the human body and its parts. Today's cell phones and tablets allow students to carry offline applications (apps) with them that detail the human body in comparable detail to the online versions. Computer modeling and other e-resources are also available.

Animal specimens have been substituted for human cadavers for more than two thousand years. The Greek physician, Galen, used primates to teach human anatomy. Galen assumed the anatomy of primates (i.e., great apes) was identical to humans. Some of the commonly used specimens include fetal pigs, mink, rats, cats, and dogs. Other specimens, such as cows and sheep, have specific organs commonly dissected that are similar in size or structure to humans. The consensus is that the dissection of animals (as a replacement to cadavers) began after laws were enacted prohibiting the dissection of humans. Animal dissections did not carry the same stigma as human cadavers, as animals were considered expendable. Animals could readily be obtained, but until legalized, the anatomist was required to obtain their own cadaver or turn to entrepreneurs known as "Resurrectionists" or "body-snatchers" (Hosey, 2015). Each specimen type has

limitations when compared to the human body. Although comparable in many ways, animal specimens often lack similar organ placement, size, vessel routing, and other important anatomical features. The most obvious limitation is that these animal specimens are not human. Most animal specimens used today are by beginning anatomy classes or for practicing surgical techniques.

Anatomical models were introduced to supplement the short supply of healthy corpses (Engelking, 2014). Artists and physicians as far back as the 14th century created wax-injected limbs (Markovic and Markovic-Zivkovic, 2010), ivory parturition dolls, diagnostic dolls (used by physicians to allow patients to point to problem areas), paper-mâché brains, wax models, and ivory eyes (Olry, 2000). Before the discovery of x-rays in 1895, the only practical way to see inside the human body was to observe an operation or dissection. Cultural and religious beliefs about dissection often made the practice illegal. Even when dissection was accepted, cadavers were still difficult to obtain. Moreover, lack of refrigeration meant that bodies decomposed swiftly. Dissections had to be performed during the cooler months of the year and were impossible in warmer climates. A young French anatomist and physician, Louis Thomas Jerome Auzoux, devised an elegant solution—paper-mâché anatomical models (Olry, 2000). The first recorded use of plastics for an anatomical model was in 1930 by German artists for The German Museum of Hygiene (Markovic and Markovic-Zivkovic, 2010). Today, plastic models are used extensively in anatomy classrooms because of their low cost and anatomical details they provide. Current plastic models are designed to be dismantled and reassembled as part of the learning experience. The ultimate models (plastinates) are created from the injection of chemicals into fresh cadavers. The use of 3D anatomical models can be found

throughout medical educational institutions. 3D models omit the clutter and complexity of a cadaver to aid in the clarification of structures that could be missed in situ. Initial and ongoing costs and safety concerns of 3D imaging and printing restrict some institutions from using 3D technology (Fredieu, et al., 2015).

Advantages of Using Human Cadavers

When cadavers are used in Human Anatomy courses they may be prosected or the students themselves may perform the dissections. Cadavers provide students a more accurate perspective of size, location, and surrounding structures when compared with computer models and textbooks (Kulkarni, 2013). This knowledge of normal anatomy allows students to conceptualize abnormal anatomy (Perry and Kuehn, 2006). The use of cadavers may be the ultimate in experiential learning (Dawson, 2013). For many students, a gross human anatomy class that uses cadavers will be their first time to see a dead body and will be an experience that changes them forever (Kzirian and Bee, 2010). When working on cadavers, students are confronted with sights and smells that are proprietary to cadavers and not experienced while performing or observing virtual dissections.

One of the most valuable aspects of the anatomy lab experience is gaining an appreciation of human variability (Granger, 2004; Topp, 2004). Because textbook pictures in anatomy books identify average (or typical) condition they do not faithfully represent any live or dead person since no one person is 100 percent average (Lewis, 2013). Cadaver dissection remains as the pillar for teaching and learning of anatomy in

most medical schools (Kahn and Mirza, 2013). Students using cadavers are able to gain more knowledge than just the identification of body parts. They can also look into how people die and the effects that illnesses have on the human body (Shaikh-Lesko, 2013). Dissection helps in developing a spatial and tactile appreciation for the fabric of the human body that cannot be achieved by prosection or computerized learning aids alone (Rath and Garg, 2006). The proponents of using electronic representations of the body to teach anatomy are being questioned, as there seems to be a widespread consensus that these resources are currently inadequate to be anything other than a support to anatomy learning by other means (McLachlin and Patten, 2006).

METHODS AND MATERIALS

In this study, a questionnaire was used to collect opinions of students enrolled in a dedicated human anatomy course (a one-semester course focusing only on human anatomy) regarding the usefulness of cadavers.

Study Population

The questionnaire was administered to students enrolled in college-level gross human anatomy courses in the Oklahoma City metropolitan area from the fall semester of 2013 through the summer 2014 semester.

There are 12 institutions of higher education in the Oklahoma City metropolitan area. Seven of these offer a gross (the study of organs, parts, and structures of the human body that can be seen with the naked eye) human anatomy course. All courses use models and some use cadavers and models. Four of the institutions participated in the study, whereas the other three declined. The total available sample size in these seven institutions was 964 students. The four participating institutions had a possible 620 students in the study. Due to scheduling complications, 64 of these students were not able to participate. The final sample size of 556 students were separated into two groups. The "cadaver using group" consisted of 371 students attending institutions in which the human anatomy course used both cadavers and models. The "model only group" consisted of 185 students attending institutions which use only models in their human anatomy course.

The three institutions not participating in the study consisted of a possible sample size of 344 students. All of these institutions used cadavers and models. The 64 students not included from the four participating institutions were also from institutions that used cadavers.

Data collection was scheduled with the instructors of record within the final two weeks of each semester. Data collection times were at the beginning of class or at the end of class. Students were allotted 15-20 minutes to complete the data collection instrument.

The responses provided by students were totally anonymous as the Institutional Review Board (IRB) at the University of Central Oklahoma granted a waiver of consent forms which required student signatures. The instructor for each class was requested to leave the room as the survey was administered.

Questionnaire

The questionnaire was composed of three major sections: 1) questions for gathering facts, 2) statements requesting opinions, and 3) a test using photos of cadavers and photos of models. The questionnaire implemented a Likert Scale Ranking similar to earlier studies (Mitchell, 2004; Dehoff, Clark, and Meganathan, 2011; Zurada, Gielecki, Osman, Tubbs, Loukas, Zurada-Zielinska, Bedi, and Nowak, 2011) and the ranked opinions (such as agree/disagree) were converted into nominal data. The data extracted from the study produced mean values that were used in *t*-test calculations for defined groups, producing quantifiable values and a method to determine significance of various factors between groups.

Questions for Gathering Facts

Students who participated in the study were presented with 13 questions (Q1 through Q13) used to gather demographic data and other personal information that might be important in relating to student opinions about the use of cadavers in a human anatomy course.

Statements Requesting Opinions

Students who participated in the study were presented with 12 statements (S14 through S25) that emphasized five aspects of an experience involving cadavers in a human anatomy classroom. They were directed toward the learning experience, the appreciation of pathology, the possible emotional impact of using cadavers, the safety concerns associated with cadavers, and the possible impact of using cadavers on their future in a healthcare program or profession.

For each of the statements only four responses were possible: strongly agree, slightly agree, slightly disagree, and strongly disagree. Careful consideration for this design of the response possibilities was used so that there was not an option for participants to be neutral regarding their opinion about any statement presented.

Six statements were written with a positive emphasis on cadaver use so that a strongly agree response would indicate that cadavers are definitely useful in human anatomy. These are referred to as “pro-cadaver” statements. The other six statements were written so that a strongly agree response would reflect that cadavers are not essential in human anatomy or may even have a negative influence. These are referred to

as “pro-model only” statements. These 12 statements were randomly ordered on the questionnaire.

For the six pro-cadaver statements, a “strongly agree” received a score of 4, “slightly agree” a score of 3, “slightly disagree” a score of 2, and “strongly disagree” a score of 1.

For the six pro-model only statements, a “strongly agree” received a score of 1, “slightly agree” a score of 2, “slightly disagree” a score of 3, and “strongly disagree” a score of 4.

The score for the statement- “The usage of cadavers facilitates the learning of human anatomy,” which is a pro-cadaver statement, was determined as follows:

Strongly agree (*n* = 453)	453 x 4 = 1812 points
Slightly agree (*n* = 88)	88 x 3 = 264 points
Slightly disagree (*n* = 13)	13 x 2 = 26 points
Strongly disagree (*n* = 2)	2 x 1 = 2 points

The total number of points (2104) was divided by the number of students (*n* = 556) to obtain a mean score of 3.78. The same process was carried out for the other five pro-cadaver statements.

Scoring for the statement- “Models provide a sufficient learning process of the human body,” which is a pro-model only statement, was determined as follows:

Strongly agree (*n* = 254)	254 x 1 = 254 points
Slightly agree (*n* = 190)	190 x 2 = 380 points
Slightly disagree (*n* = 87)	87 x 3 = 261 points
Strongly disagree (*n* = 25)	25 x 4 = 100 points

The total number of points (995) was divided by the number of students (n = 556) to obtain a mean score of 1.79. The same process was carried out for the other five pro-model only statements.

Therefore, the higher scores represent opinions that reflect a more positive view concerning the use of cadavers in a human anatomy course. The highest score possible was 4.00 and the lowest possible score was 1.0. Any statement scoring 4.0 would reflect that all students agreed if it was a pro-cadaver statement and disagreed if it was a pro-model only statement. Conversely, a score of 1.0 would reflect that all students disagreed with pro-cadaver statements and agreed with pro-model only statements.

When comparing the two study groups (the cadaver using group and the model only group) for opinions on any statement with a *t*-test, the group with the higher score would represent students who most likely agree with the pro-cadaver statement and disagree with the pro-model only statement. Conversely, the group with the lower score would represent students who most likely disagree with the pro-cadaver statement and agree with the pro-model only statement.

Table 1 summarizes the opinion section of the questionnaire and lists the statements, indicates which statements reflect the different aspects of cadaver use in human anatomy courses, statements which reflect a pro-cadaver viewpoint versus a pro-model only viewpoint, and the resulting score for each statement.

Student responses to the fact gathering questions were entered into Excel, with each response placed in a separate column (A through M). Categorical data for statements S14 through S25 were manually converted (using Likert Scale conversion) to numerical

data and entered into columns N through Y. Each student was assigned a row (1-556) for all responses. Statistically weighted means (scores) were calculated using Excel. All *t* and *p* values were calculated using independent 2-sample *t*-tests on a TI-83 Plus using a standard deviation of 1.0, with a significance identified when $p < 0.01$.

Test Using Photos of Human Cadavers and Photos of Models

Retention of knowledge was not an objective for this study because of too many variables involved that cannot be measured or controlled (such as required objectives between institutions, differences in instructor methods, model selection and quality, etc.). However, as a pilot study to determine the practicality of an exam to measure retention of anatomical structures, a series of photos of cadavers and models were presented to the subjects. Study participants were asked to identify specific anatomical structures.

Hypotheses

The overall expectation of this study is that students enrolled in human anatomy classes that use cadavers will have different opinions about the usefulness of cadavers from students enrolled in human anatomy classes without cadavers.

H^0 - there will be no difference between students from cadaver anatomy classes and non-cadaver classes

H^1 - students from classes that use cadavers will have more positive attitudes toward the use of cadavers than students from anatomy classes that do not use cadavers

RESULTS

Descriptive Data

The descriptive data gathered by the questionnaire were as follows: Age (Fig. 1), college classification (Fig. 2), gender (Fig. 3), and ethnicity (Fig. 4) were the major demographic variables.

Prior courses in college human anatomy (Fig. 5), number of college-level anatomy courses taken (Fig. 7), high school Human Anatomy (Fig. 7), and college Human Physiology (Fig. 8) was determined. The reason for taking the human anatomy course (Fig. 9) and exposure to cadavers prior to taking the human anatomy course (Fig. 10) was also elicited. The frequency that students used cadaver-related DVDs (Fig. 11) and online cadaver-related sites (Fig. 12) were also asked of students who participated in the study.

Question eleven (Fig. 13) repositioned the students in the two study groups (the 371 students in the cadaver using group and the 185 students in the model only group) into two different groups, based on preconceived notions about the use of cadavers before students attended classes. The students in the cadaver using group were asked if they were concerned or not concerned that cadavers were to be used. Students in the model only group were asked if they were disappointed or relieved cadavers were not going to be used. The two new groups formed were: 1) students in the cadaver using group who were not concerned cadavers were to be used plus students in the model only group who were disappointed cadavers were not to be used, and 2) students in the cadaver using

group who were concerned cadavers were to be used plus the students in the model only group who were relieved that cadavers were not going to be used.

The Learning Aspect

The two pro-cadaver statements concerning the learning aspect had high scores. These scores represent the consensus of both study groups that cadavers facilitate the learning of human anatomy (3.78, Fig. 14) and cadavers provide the most realistic and accurate understanding of the human body (3.80, Fig. 15). Regardless of whether or not students had cadavers in their human anatomy course and regardless of any variable measured, most students agreed with both statements. No *t*-tests were necessary for these two statements and the null hypothesis is accepted for both. For these two statements an acceptance of the null hypothesis supports that cadavers are useful additions to human anatomy classes.

One pro-model only statement concerning learning asked student participants if human anatomy DVDs/online would be a suitable substitute for using cadavers in class. The above average mean score of 2.93 (Fig. 16) reflects a tendency for many students to disagree with that statement. When comparing the two study groups, the cadaver using group had a significantly higher mean score than the model only group (3.20 versus 2.39, respectively; $t = 8.999$, $p < 0.01$). Therefore, the cadaver using group was more likely to disagree with that statement than was the model only group. This supports the alternative hypothesis.

Of the possible confounding variables, two major demographic variables (gender and ethnicity) were eliminated because the frequency distribution between the two study groups was the same for both. In relation to this statement, two variables were obtained: 1) the frequency that students used cadaver online sites (Fig. 12) and 2) the frequency that students used DVDs as a tool to study human cadavers (Fig. 11). The frequency of using cadaver online sites eliminated as a confounding variable because the distribution between the two study groups was basically the same. The use of DVDs to study human cadavers was eliminated as a confounding variable because 97% of all student participants reported that they never or infrequently used DVDs as a study tool.

The age distribution between the two study groups was slightly different. When dividing the age of the student participants into two groups (< 22 years of age versus 22 years of age and older, Fig. 1) the cadaver using group was slightly younger-- 49% of the cadaver using group were < 22 years of age, whereas only 30% of the model only group were < 22 years of age. There was a significant difference between these two age groups concerning the use of digital technology (i.e., DVDs and online sites) to study the anatomy of human cadavers. The younger students had a higher score than the older students (3.03 versus 2.86, respectively; $t = 1.995$, $p < 0.01$). Therefore, the younger students were more likely to disagree with the statement. Of the 12 statements, this was the only statement showing a significant difference due to age.

This statement created a somewhat conflicting result. Whereas the overall score of 2.93 reflects a general overall disagreement with this statement, 97% of the students never or infrequently use cadaver DVDs and 78% never or infrequently use cadaver

online sites. Therefore, what they are basing their opinions on is not clear as the majority of students reported they do not use these resources.

The other pro-model only statement regarding the learning experience (S15 – Table 1) had the lowest mean score (1.79, Fig. 17). This reflects that most students, regardless of whether they were affiliated with the cadaver using group or model only group, agreed that models provide sufficient learning. No *t*-test was necessary for this statement and the null hypothesis was accepted. In this case, the acceptance of the null hypothesis does not support that cadavers are a useful addition to a human anatomy class. This will be discussed again with a similar statement concerning models.

The Pathology Appreciation Aspect

One pro cadaver statement was concerned with the appreciation of pathology that models do not replicate (S16 – Table 1). The high score of 3.52 (Fig. 18) reflects that basically all students agreed with this statement. Therefore a t-test was not necessary and the null hypothesis was accepted. This would support the notion that the addition of cadavers to a human anatomy course would provide a useful aspect for beginning-level students to begin to acquire a basic understanding of pathology that is not provided by model only courses.

The Emotional Aspect

The pro-cadaver statement was concerned with a greater self-awareness of your body (S21 – Table 1). The high mean score of 3.70 (Fig. 19) reflects that basically all students agreed with this statement. A *t*-test was not necessary and the null hypothesis was accepted. This supports that the inclusion of cadavers in a human anatomy course provides a useful component not possible with a models only course.

The pro-model only statement dealt with a possible hindrance to learning for students that are sensitive to viewing a human cadaver (S17 – Table 1). The above average mean score of 2.72 (Fig. 20) reflects that most students would disagree with this statement. When comparing the cadaver using group with the model only group, the cadaver using group scored significantly higher than students in the model only group (2.82 versus 2.52, respectively; $t = 3.333$, $p < 0.01$). Therefore, the cadaver using group was more likely to disagree with this statement. This supports the alternative hypothesis.

The Safety Aspect

The one statement concerning safety was a pro-model only statement (S18 – Table 1). The above average mean score of 2.92 (Fig. 21) reflects that many students disagree that the learning process will be hindered due to possible health issues. When comparing the cadaver using group, there was a significant difference with the cadaver using group having a higher mean score than the model only group (3.01 versus 2.75, respectively; $t = 2.889$, $p < 0.01$). Thus, the cadaver using group was more likely to disagree with this statement. This supports the alternative hypothesis.

The Healthcare Profession Aspect

The first pro-cadaver statement (S22 – Table 1) had a high mean score of 3.80 (Fig. 22). As with previous statements with high mean scores, this reflects that basically all students agreed with this statement. Therefore, both the cadaver using group and the model only group mainly agree that having cadavers in a human anatomy class will better prepare students for a healthcare profession. No *t*-test was necessary and the null hypothesis was accepted. This supports that the inclusion of cadavers in a human anatomy class has useful consequences.

The other pro-cadaver statement (S24 – Table 1) had an average mean score of 2.60 (Fig. 23). This reflects that about equal numbers of students agreed and disagreed with this statement. The cadaver using group had a significantly higher mean score than the model only group (2.70 versus 2.38, respectively; $t = 3.555$, $p < 0.01$). Therefore, the cadaver using group was more likely to agree that acceptance into a healthcare profession could be influenced by whether a student took a human anatomy course that included cadavers. The alternative hypothesis was accepted for this statement.

The first pro-model only statement (S23 – Table 1) also had an average mean score of 2.50 (Fig. 24). This reflects that basically equal numbers of students agreed and disagreed that success in a healthcare profession is independent of whether cadavers were used or not in their human anatomy course. There was no significant difference between the scores of the cadaver using group and the model using group (2.46 versus 2.59, respectively; $t = -1.444$, $p > 0.01$). The null hypothesis was accepted for this statement.

The other pro model only statement (S25 – Table 1) likewise had an average mean score of 2.50 (Fig. 25) which reflects that equal numbers of students agreed and disagreed that a model-based human anatomy course is sufficient for success in a chosen healthcare profession. There was a significant difference between the study groups with the cadaver using group having a higher mean score than the model only group (2.78 versus 1.96, respectively; $t = 9.111$, $p < 0.01$). Therefore, the cadaver using group was more likely to disagree with this statement. This supports the alternative hypothesis.

For this statement, the classification variable also showed a significant finding. The classification variable (Fig. 2) was divided into lowerclassmen (which included freshmen and sophomores) and upperclassmen (which included juniors, seniors, and students that already had a B.S. degree and were not in a graduate program but were taking human anatomy for a variety of other reasons). The upperclassmen had a significantly higher score than the lowerclassmen (2.65 versus 2.36, respectively; $t = -3.419$, $p < 0.01$).

The possible role that classification had as a confounding variable was clarified with an analysis of this statement. Three facts existed. First, the upperclassmen had a higher score than the lowerclassmen. They were more likely to disagree with the statement. Second, the cadaver using group had a higher score than the model only group. They were more likely to disagree with the statement. Third, the cadaver using group had a higher percentage of upperclassmen. Upperclassmen comprised 65% of the cadaver using group, but only 37% of the model only group. The question this poses is if the variable of classification of student participants is controlled, would the difference still be evident when comparing the cadaver using group with the model only group. The answer

was yes. The score for cadaver using upperclassmen was still significantly higher than the model only upperclassmen (2.82 versus 2.11, respectively; $t = 5.13$, $p < 0.01$).

The role of models was addressed in two statements. The first statement, S15, stated that models provided a sufficient learning process for students studying the human body. As previously noted, this statement had a low mean score (1.79, Fig. 17) and suggested that all students agreed that models were sufficient. The second statement, S25, stated that a model-based human anatomy course is sufficient for success in a chosen healthcare profession. As indicated above, this statement had a mean score of 2.5 (Fig. 25) and the cadaver using group had a significantly higher score than the model only group which was significant (2.78 versus 1.96).

Of the 556 students who participated in the study, 85 students disagreed with both statements and 261 students agreed with both statements. It is interesting to note that 210 students changed their mind when answering S25. Only 27 students disagreed with S15 and then agreed with S25. However, 183 students that agreed with S15 disagreed with S25. These 183 students went in the direction that supports the alternative hypothesis. For S15, the null hypothesis was accepted. For S25, the alternative hypothesis was accepted. A possible explanation might be that S25 was a more powerful and inclusive statement which incorporated a future consequence for having a cadaver-based human anatomy course.

Original Study Groups versus New Study Groups

Question 11 (Fig. 13), as previously shown, provided a different way to separate the 556 students into two separate groups based on preconceived ideas they had before taking their respective human anatomy course. Group 1 (labeled pro-cadaver students) consisted of students who were not concerned cadavers were to be used in their human anatomy course plus the model only students who were disappointed cadavers were not going to be used. Group 2 (labeled pro-model students) consisted of students who were concerned cadavers were to be used in their human anatomy course plus model only students who were relieved cadavers were not going to be used.

The frequency distribution was nearly identical for both groups. Of the 556 students, 66.7% (n = 371) made up the group of students using cadavers and 33.3% (n = 185) made up the group that only used models in human anatomy courses. Of the 556 students, 66.7% (n = 371) made up the pro-cadaver students and 33.3% (n = 185) made up the pro-model students.

The statistical finding was similar for the two new groups to those of the original two study groups. For the comparisons between the group that used cadavers and the group that only used models, seven of the statements resulted in an acceptance of the null hypothesis. For the other five statements, the alternative hypothesis was accepted. For the comparison of the pro cadaver students versus the pro model students, nine statements resulted in the acceptance of the null hypothesis and three resulted in the acceptance of the alternative hypothesis. The two statements that changed from acceptance of the alternative hypothesis to the acceptance of the null hypothesis were S24 and S25 (Table 1).

Results of Testing

The results for the testing portion of the data collection instrument produced low mean scores regardless of any variable. Only 27 students (7.4%) of cadaver-based courses and 6 students (1.6%) of model-based courses answered enough questions correctly to receive a passing score using the cadaver photos. It is interesting to note that none of students in either group passed using model photos (Table 2).

DISCUSSION

During the past eight years, the author has observed several hundred human anatomy students in cadaver-based classes from the perspective of a student, multiple times as a teaching assistant for five different professors, and for several years as an instructor (S. Smith, *personal observation*). Most of these students were excited and eager to study the cadavers while a few chose to avoid them as much as possible. Research has shown that students entering cadaver labs are faced with an "emotional experience" requiring them to confront death and mortality, which in turn challenges them to quickly mature (Robbins, 2008). Model only groups forego this crossroad, and may even select the type of anatomy course they will attend based on preconceived ideas about the use of cadavers, regardless of prior cadaver exposure. This study found that students who enroll in human anatomy courses that only use models choose their institution based on factors other than having cadavers in the class or not. Every human anatomy course uses models, either exclusively or in conjunction with cadavers; however, major differences exist in the learning experience depending on the anatomy curriculum selected. The decision by school administration and professors to add cadavers to an existing model-based course, continue using cadavers, or even discontinue the use of cadavers is made without considering the opinions of students. Do undergraduate-level students consider cadavers as "vital" or "dispensable" to their human anatomy education? The expectation of this study was that undergraduate-level students who attend institutions that use cadavers in their human anatomy courses and students enrolled at institutions that use only models would hold contrasting opinions regarding the usefulness of cadavers. A search of the peer-reviewed literature revealed that opinions

regarding the usefulness of cadavers of undergraduate (pre-medical school) students who enroll in gross human anatomy had never been considered. One focus of this research project was to determine if student opinions about the usefulness of cadavers agreed with the expectations of this study.

When possible, many professors prefer to use models in conjunction with cadavers to teach human anatomy. If human cadavers are not available, instructors rely on models to provide visual affirmation of lecture material for students. Models provide the basics of anatomy in a package that most students can absorb. Models represent components of the human body, often including numeric indicators placed on basic structures for easy identification, and most plastic models are durable enough to be used for decades. In short, models are made for the masses. Many good models are available, especially for microscopic structures, but none of them portray the reality of the human body. Fatty tissues found surrounding organs, in facial compartments, and enveloping vascular/neuronal bundles are never seen on models. Fascia is another key component to the human body that is omitted from models. In addition, the appreciation of pathology, such as cancer and obesity are rarely depicted on models, which removes the variability and individuality from learning. The addition of cadavers provides students with supplemental visual and emotional experiences that are often needed for retention of material.

An underlying objective for this project was to gain a better understanding regarding the opinions of undergraduate students who are not exposed to cadavers in beginning-level human anatomy courses. Undergraduate students who had the opportunity to learn from cadavers had the advantage of having experienced one or more

cadavers in class on which to base their opinions, whereas students from model only courses were asked to give opinions regarding the usefulness of cadavers, with little or no experience on which to base their opinions. Students from model only courses relied on anecdotal evidence and preconceived thoughts about cadavers to respond to the statements in the questionnaire that was included in this study. The University of Central Oklahoma IRB waived all signatures for participants in this study, which allowed students to respond in a manner that reflected their honest opinion. There were also time constraints for the questionnaire; therefore, students did not have time to analyze the statements. For these reasons, responses from those students who had never been exposed to cadavers or had little exposure to cadavers must have based their opinions on preconceived ideas. Regardless, all students have opinions about the usefulness of cadavers in undergraduate courses focusing on gross human anatomy.

For this study, a null hypothesis based on high mean scores reflects a positive attitude towards cadaver use. The null hypothesis (there would be no statistical differences between opinions from students enrolled in cadaver based human anatomy classes and students enrolled in human anatomy classes that only used models) was accepted for seven statements. In five instances, the null hypothesis was accepted due to high scores on pro-cadaver statements. This reflected that basically all students agreed with the statements. Most students who participated in the study agreed that: 1) cadavers facilitate the learning of human anatomy, 2) cadavers provide better appreciation of pathologies – such as cancer and obesity, 3) use of cadavers would provide the most realistic/accurate understanding of the human body, 4) cadavers could provide a student with a greater self-awareness of their own body, and 5) the use of cadavers better

prepares a student for a career in the healthcare profession. The consistency between student groups for these statements was not expected. As mentioned previously, the expectation before the study was conducted was that opinions of the two groups of students (cadaver using group vs. model only group) would differ in a variety of ways. Regardless of their course affiliation and experience with cadavers, students from model only courses also saw the value of adding cadavers to an existing model-based curriculum. Additionally, the responses to Q11 reflected nearly a 3:1 ratio of model only group students that were disappointed their course did not include the use of human cadavers. The results for these five statements and the results for Q11 indicate the possibility of other factors determining student's selection of a cadaver-based or model-based course. Other variables, such as cost, location, or class availability (time of day class was held or class being full) could have influenced the institution which was chosen by the students. For one statement the null hypothesis was accepted for a pro-model only statement due to a low mean score. For this statement (models provide sufficient learning for human anatomy), the acceptance of the null hypothesis was not in favor of cadaver usefulness. The null hypothesis was accepted due to a non-significant *t*-test for one pro-model statement-- that success in a healthcare profession is independent of whether or not your human anatomy course used a cadaver. The alternative hypothesis was accepted on five statements, one of which was a pro-cadaver statement (there is a possibility that acceptance into a nursing program or other healthcare profession program could be influenced by whether a cadaver was used in a human anatomy course) and four that were pro-model only statements (human anatomy DVDs/online would be a suitable substitute for using cadavers in class; the usage of cadavers may hinder the learning

process for students that may be sensitive to viewing a cadaver; the usage of cadavers may hinder the learning process for students concerned with possible health issues related to the cadavers; and a model-based human anatomy course is sufficient for success in a chosen healthcare profession). For this study, 10 of the 12 statements reflected a positive view of cadavers.

The study investigated five aspects of human anatomy experiences involving cadavers (Table 1). The five aspects were: 1) learning, 2) pathology appreciation, 3) emotional impact, 4) safety, and 5) healthcare profession impact. Two learning aspect statements (S14, the usage of cadavers facilitates the learning of human anatomy; and S20, the usage of cadavers in human anatomy classes would provide the most realistic/accurate understanding of the human body) showed a pro-cadaver emphasis and received high mean scores. The mean scores indicate nearly every student agreed that when viewed as a tool for learning, human cadavers were useful. As mentioned previously, the responses support the null hypothesis and the model only group responded nearly identical to the group that used cadavers for their course in human anatomy. The two remaining learning aspect statements (S19, human anatomy DVDs/online would be a suitable substitute for using cadavers in class; and S15, models provide a sufficient learning process of the human body) showed a pro-model only emphasis and scored above average and low, respectively. S19 responses indicate that most students who participated in the study disagreed with the statement that DVDs are a suitable substitute for using a cadaver in class. In addition, the study revealed that 97% of the students never or infrequently used DVDs as a resource, so the basis for the score on S19 is questionable. The responses to S19 and Q12 also indicate that the concern from

researchers in 2004 (that cadaver dissections were no longer needed due to advances in technology-savvy instructional tools (Guttman, *et al*., 2004; McLachlan, 2004; Topp, 2004; Shaffer, 2004) was not supported by the findings in this study. Student reliance on technology has not exceeded the learning effectiveness of traditional use of cadavers, which supports the research in 2014 from Michigan State University that found the traditional use of cadavers in teaching proves to be a better choice for learning than computer simulated models (Saltarelli, *et al.*, 2014). S15 discussed below.

Regarding appreciation for aspects of pathology, only one statement (S16) was presented, maintaining a pro-cadaver emphasis. The results to S16 indicate that nearly all students were in agreement that cadavers provide a better appreciation of pathologies. Typically, the cadavers possess a great amount of adipose tissue that must be removed prior to viewing relevant anatomical structures. In addition, human cadavers provide the student with the opportunity to observe various forms of cancer, bed sores, and broken bones. These pathologies can only be appreciated through the examination of cadavers. Model only students recognized the lack of pathological disorders on their models and responded to this statement accordingly. Because most of the students (96% - Q9, Fig. 9) who participated in this study were aspiring to careers in nursing or other health-related fields, the exposure to these pathologies allowed them to recognize similar pathologies in future courses and medical conditions of their future patients.

Two statements addressed the possible emotional impact cadavers cause students when used in human anatomy courses. The first statement revealed that nearly all students agreed that cadavers allow students to realize their own individuality. Students from courses that used cadavers were able to witness how different each cadaver was

from the models, likely noticing the details that defined the cadaver's individuality and the structures that were similar to or unlike their own. Students from the model only group had little reference to base their opinion on other than how they imagined a cadaver would increase their self-awareness. This statement allowed these students to mentally place themselves in a course that used cadavers and sense whether they felt different inside. Because nearly every model only student responded to the statement favoring the acceptance of the null hypothesis, they were able to overlook the negative physical and emotional effects that first-time cadaver-using students experience (Robbins, 2008). The pro-model only statement that addressed the emotional impact of cadavers, (S17, cadavers may possibly hinder learning for students sensitive to viewing a cadaver) showed an above average mean score; however, the students from the model using group scored significantly lower than students from the cadaver using group. Because students who used only models had not been exposed to a cadaver, the mental image of viewing a dead body would understandably cause an emotional response consistent with a significant difference in group scores. Even if model only students were not worried about cadavers affecting their learning, intuitively they understand if a student is sensitive to viewing a human cadaver, they are probably going to have difficulties completing the human anatomy course. Common sense would indicate that if a student has emotional issues when using cadavers in a controlled environment, such as the controlled setting of a human anatomy classroom, a healthcare-related career may be in question. Students who were exposed to human cadavers likely responded more favorably because of the emotional socialization, such as the tempering of emotions and feelings (sometimes referred to as affective neutrality) that allows the process of

professional training to occur (Hafferty, 1988). The apparent emotional effects of using cadavers are often reduced as students proceed through a cadaver-based course. The tempering of emotions, although taking place at an individual level, occur because of socialization and interactions between students.

One statement addressed the aspect of safety. Statement S18 (cadavers may hinder learning for students concerned with possible health issues related to using a cadaver) was less positive towards the use of cadavers, but produced an above average score. The cadaver using group and the model only group scored higher on this statement than on S17. The results indicate that both groups of students were less sensitive to the safety issues associated with cadavers than they were viewing a cadaver. Cadaver using students had experienced cadavers with few (if any) negative implications. Students from the model only group did not have experience using cadavers to anticipate injuries or health issues caused by cadavers, but the thought of seeing the cadaver was more influential than their lack of experience and caused responses to be less. The results of this statement were not expected, as it was thought most students would place greater emphasis on their health and well-being over the emotional response to viewing a cadaver. That said, the emotional component of viewing a dead body without having previously done so appears critical in the approach used to introduce undergraduate students to cadavers in human anatomy classrooms.

The aspect of cadavers having an impact on students and a possible career in a healthcare profession was addressed in four separate statements. Two statements were pro-cadaver statements and two were pro-model only statements. S22 (cadavers better prepare a student for a healthcare profession) scored the highest of all statements. The

high mean score (3.80) reflects that students from both groups believe that cadavers are significant enough to prepare students for a healthcare profession better than models alone. The results for this statement were not expected, as no contrast between the groups existed. This result was a positive statement to the usefulness of cadavers, as the consensus for both groups of future nurses, doctors, and healthcare workers was that cadavers are beneficial to prepare them for their future. This result also reflects that given the choice of cadavers in class or models only, nearly every student with aspirations of a career in a healthcare-related field chose to supplement model training with cadavers when faced with career-pertinent decisions. The second pro-cadaver statement (S24, acceptance into a nursing program or other healthcare field could be influenced by the use of cadavers), had average results as about the same number of students from each group agreed/disagreed with the statement. The results of this statement indicate that it might be too early in the curriculum for students to have visited nursing programs or other similar programs to understand what recruiters from these programs are looking for and how important anatomy is to the selection process. If the students sampled in this study were in medical school, the results of this statement (and potentially others) possibly would be different. Medical school anatomy courses often implement the usage of cadavers; therefore, student opinions may have reflected a more positive view of the usefulness of cadavers.

The first pro-model only statement (S23, success in a healthcare profession is independent of cadaver use in anatomy) also scored average. The statement was similar in composition to S24, only with a less positive wording towards the usefulness of cadavers. The results were not significant between the groups. The wording of S23 might

have caused the responses to show less contrast between groups, as both groups struggled to understand the questioning. Comparing this statement with all variables in the study, none were significant; therefore, in future studies, this statement will likely be altered for better understanding or possibly omitted due to the lack of significance observed in this study.

The second pro-model only statement (S25, a model-based human anatomy course is sufficient for success in a chosen healthcare profession), reflected a significant difference between groups. This statement was similar in wording to S15, another pro-model only statement. As S15 was a general statement, nearly all students from the cadaver using group and model only group chose to agree with the statement. Models do provide a sufficient method of leaning anatomical structures of the human body, and this has been proven in model only courses for many years. Students successfully complete model only courses and continue on to become nurses and other healthcare related workers. S25 was a more powerful statement, which asked students to reflect on their opinions regarding models being the only anatomical tools necessary to become successful in a healthcare related profession. The response to S25 held long-term implications in comparison to S15. The difference in scores for these two closely related statements indicated that students, when pressed to reveal long-term usefulness of cadavers for use in their profession, acknowledge the potential advantages of being exposed to cadavers in beginning-level human anatomy courses. S15 was seeking opinions for a shorter time frame, while S25 sought opinions that were long-term in nature.

Based on the results of this project, most students view cadavers as useful in beginning-level human anatomy classrooms. As expected, students taking a human anatomy course with cadavers were more positive in their view of usefulness. Their expression solidifies the decision by professors to use cadavers in human anatomy courses taught at their institution. For students in courses that do not use cadavers, they probably are intuitively reaching similar decisions for several of the aspects presented by the statements included in this study. Clearly, students from both groups are thinking about how cadavers and models can be implemented and utilized in their education and careers. The question of whether models are sufficient has an elusive answer. Obviously, many students are going through model-only courses and learn enough anatomy to pass the course and continue on to their respective professions. Comparing success of the two groups of students after finishing their programs and going into the work field would be difficult. Hopefully, institutions that do not use human cadavers could reference this study and possibly consider using cadavers in the future. Institutions already using human cadavers and thinking of stopping could reference this study and realize that the use of cadavers should be continued.

Table 1: Aspects of human anatomy experiences involving cadavers for students (n = 556) from 4 institutions of higher education in the Oklahoma City metropolitan area.

Pro-cadaver statement – Emphasizes positive aspects of using cadavers
Pro-model only statement – Emphasizes less positive aspects of using cadavers
Score – Reflects the level of agreement to the use of cadavers
The range of score is from 4 to 1.
The higher the score the greater the agreement to the use of cadavers.

Aspect	Statement Emphasis	Score	Statement
Learning	Pro Cadaver	3.78	S14 - The usage of cadavers facilitates the learning of human anatomy
	Pro Cadaver	3.80	S20 - The usage of cadavers in human anatomy class would provide the most realistic/accurate understanding of the human body
	Pro Model Only	2.93	S19 - Human anatomy DVDs/online would be a suitable substitute for using a cadaver in class
	Pro Model Only	1.79	S15 - Models provide a sufficient learning process of the human body
Pathology Appreciation	Pro Cadaver	3.52	S16 - Cadavers provide a better appreciation of pathologies-such as cancer and obesity
Emotional Impact	Pro Cadaver	3.70	S21 - The usage of cadavers in human anatomy classes could provide students with a greater self-awareness of their body
	Pro Model Only	2.72	S17 - The usage of cadavers may hinder the learning process for students that may be sensitive to viewing a cadaver
Safety	Pro Model Only	2.92	S18 - The usage of cadavers may hinder the learning process for students concerned with possible health issues related to the cadaver
Healthcare Profession	Pro Cadaver	3.80	S22 - The use of cadavers in human anatomy classes better prepares a student for a healthcare profession
	Pro Cadaver	2.60	S24 - There is a possibility that acceptance into a nursing program or other healthcare professions could be influenced by whether a cadaver was used in a human anatomy course
	Pro Model Only	2.50	S23 - Your success in a healthcare profession is independent of whether or not your human anatomy course used a cadaver
	Pro Model Only	2.50	S25 - A model-based human anatomy course is sufficient for success in a chosen healthcare profession

Table 2: Results of retention test for cadaver using group and model only group. Results are for identification of one anatomical structure on each of five cadaver photos and five model photos for each group, shown in percentage correct for each type of photo and overall average

	Cadaver Using Group	Model Only Group
Cadaver Photos (%)	35	13
Model Photos (%)	24	4
Average (%)	29	9

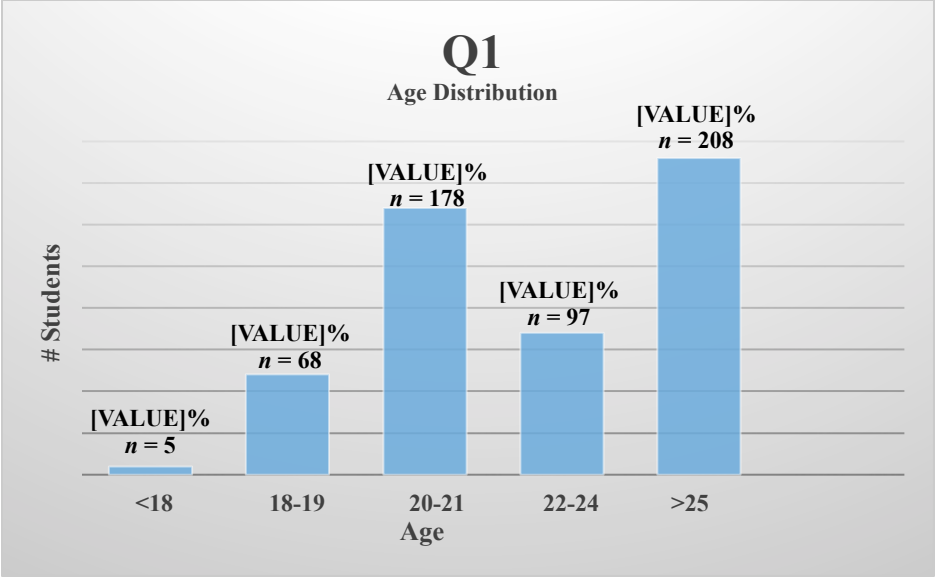

Figure 1. Age distribution of the 556 study group participants.

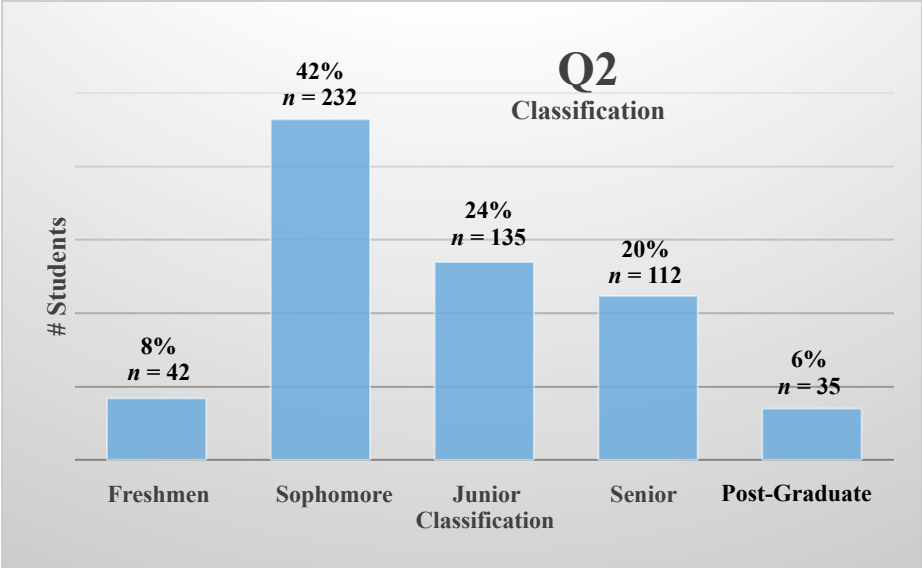

Figure 2. Classification distribution of the 556 study group participants.

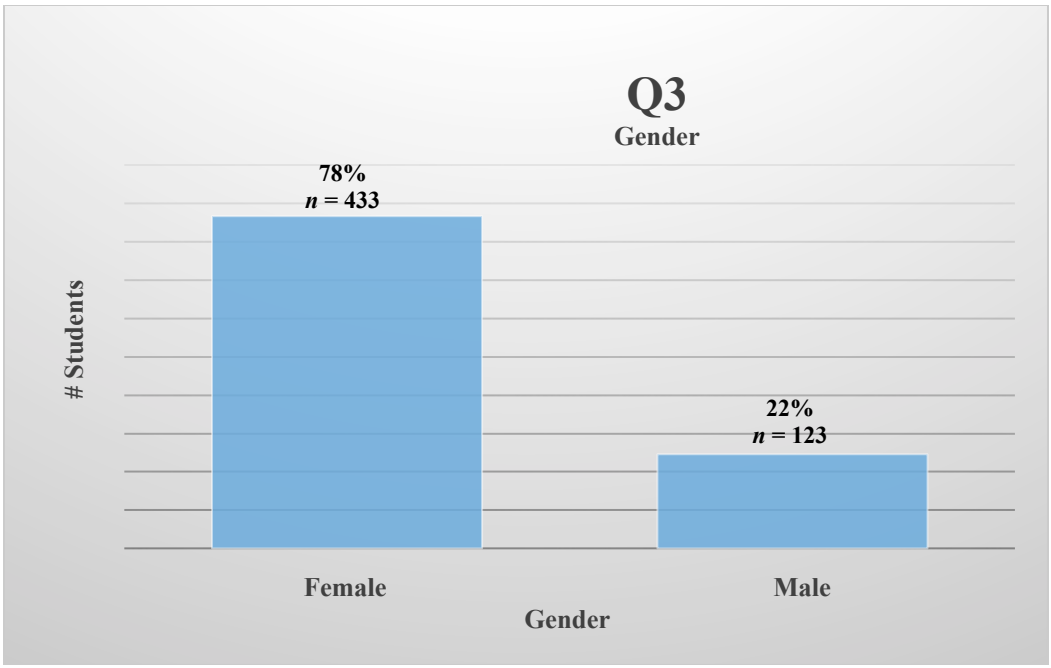

Figure 3. Gender distribution of the 556 study group participants.

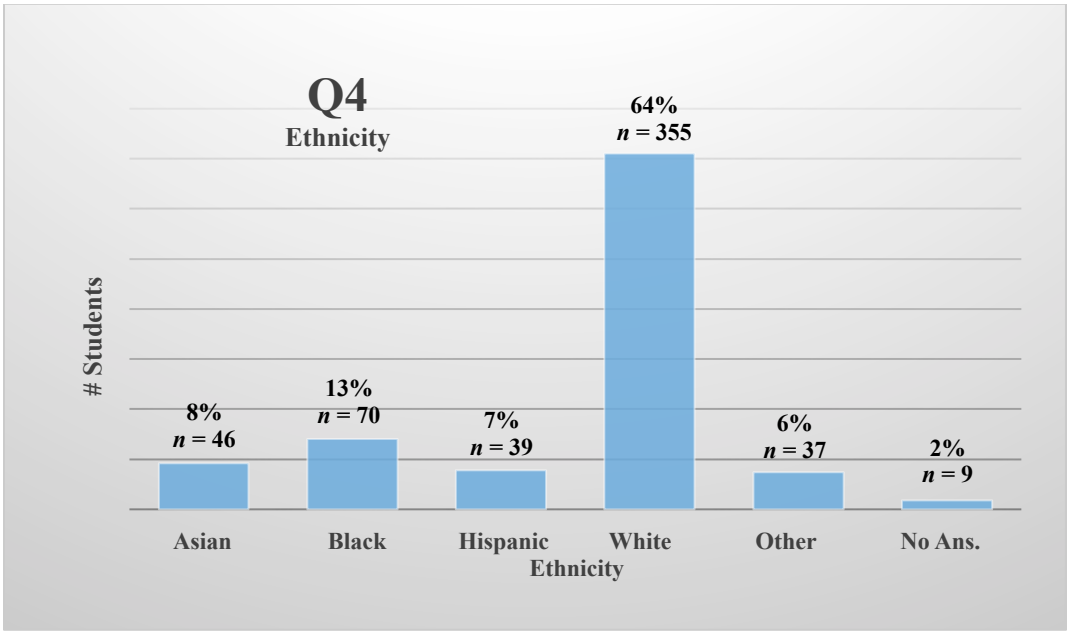

Figure 4. Ethnicity distribution of the 556 study group participants.

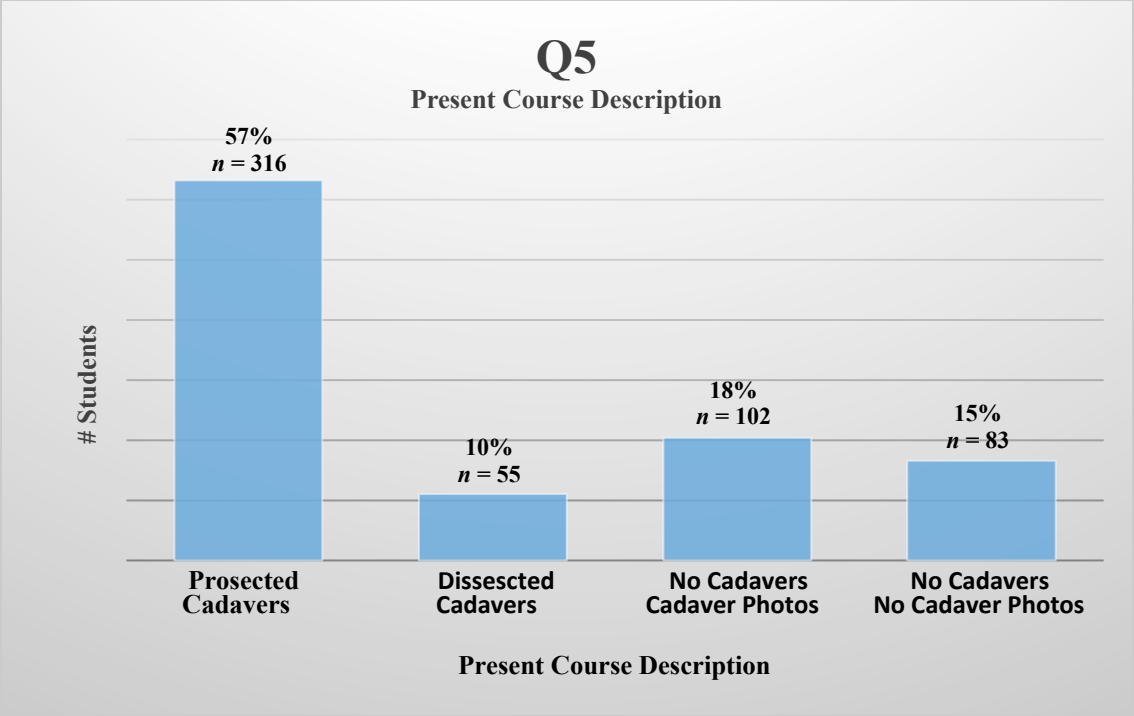

Figure 5. Present course distribution of 556 study group participants. Sample sizes include 371 students from cadaver-based courses and 185 students from model only courses.

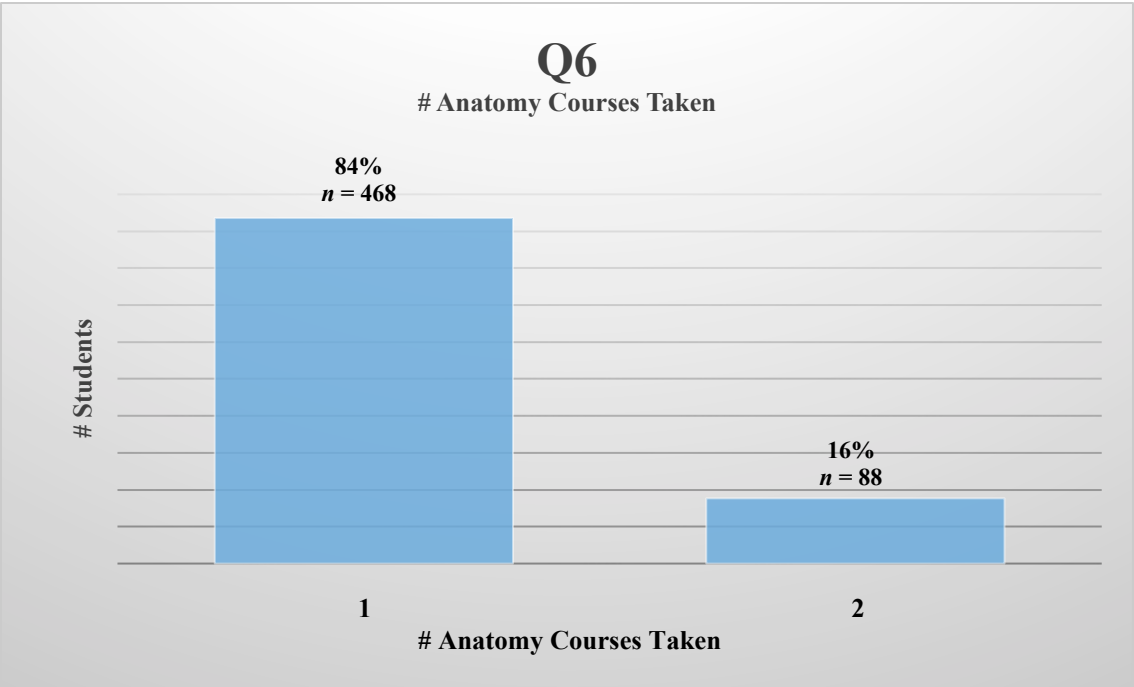

Figure 6. Number of anatomy courses reported by students (n = 556) that were taken at the college level.

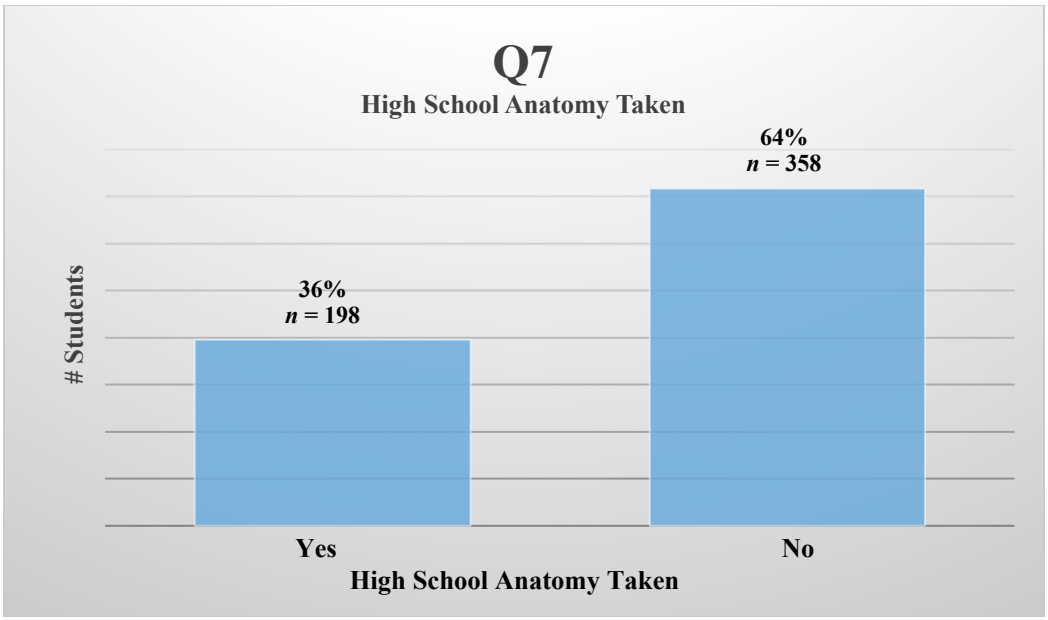

Figure 7. Number of students (n = 556) who reported that they had enrolled in an anatomy course during high school.

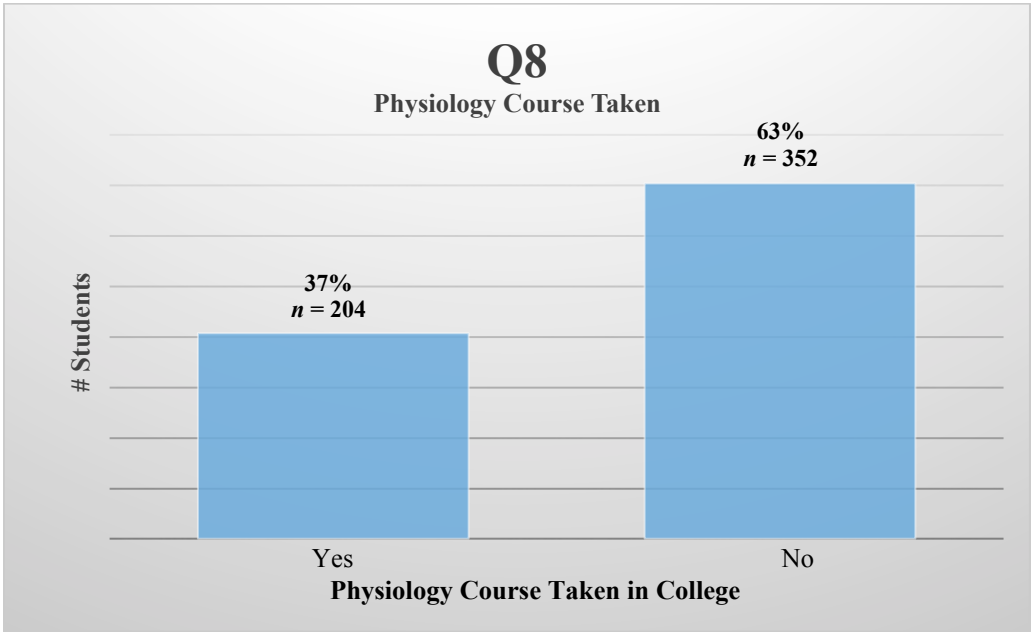

Figure 8. Number of students (n = 556) who reported that they had taken (or were currently taking) a physiology course in college.

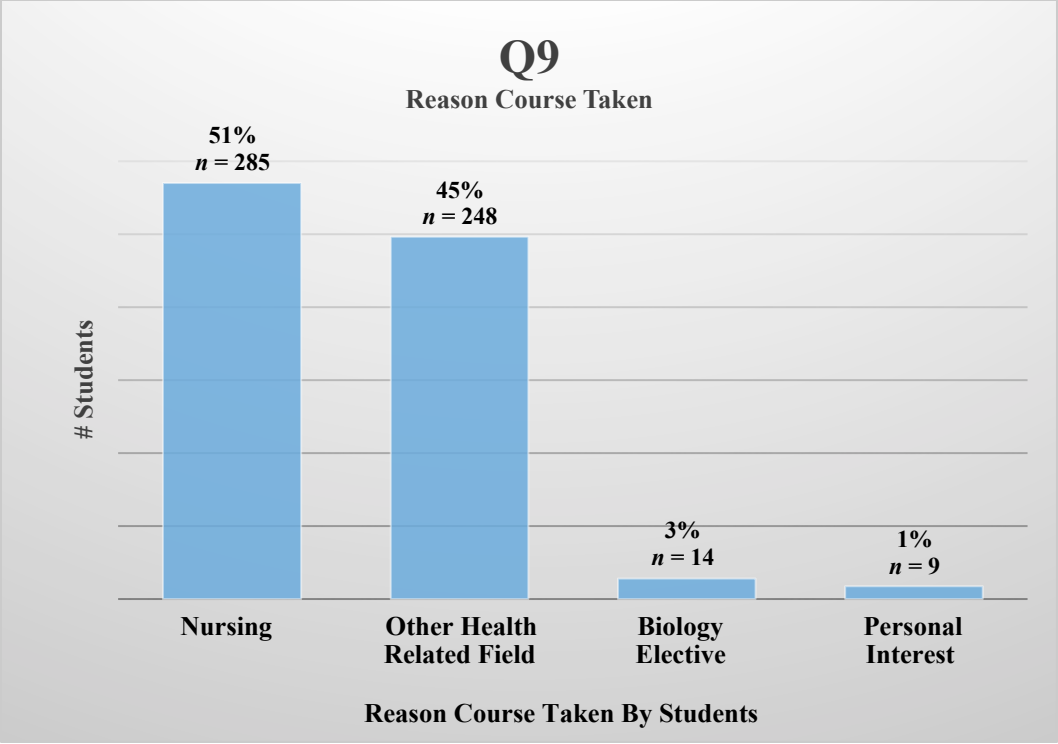

Figure 9. Reasons given by students (n = 556) why they were taking human anatomy course.

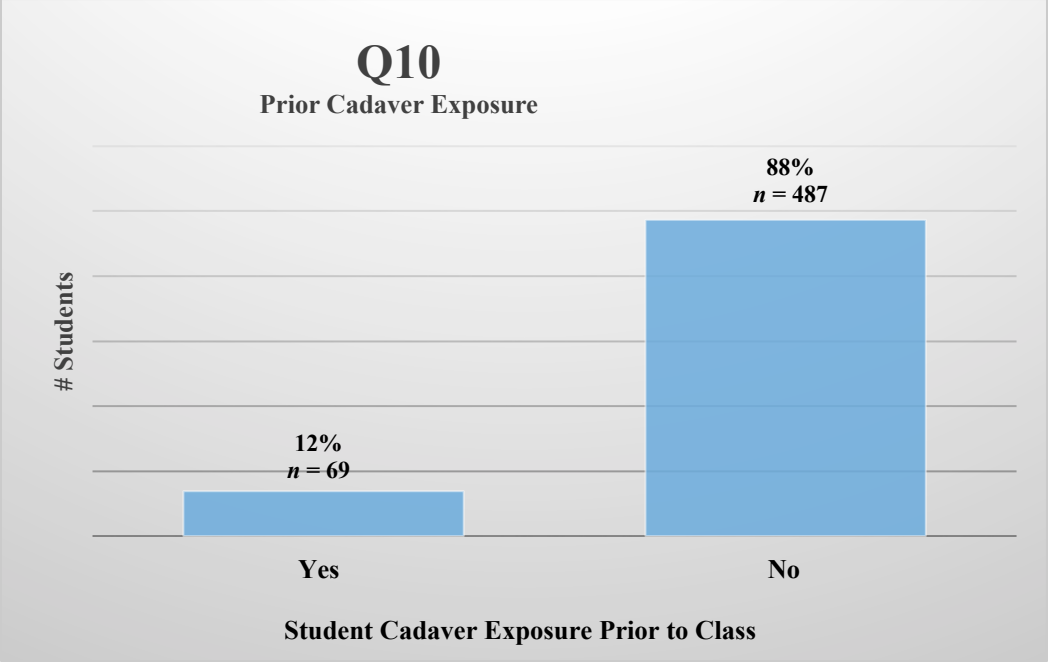

Figure 10. Number of students (n = 556) who reported that they had been exposed to cadavers prior to taking human anatomy.

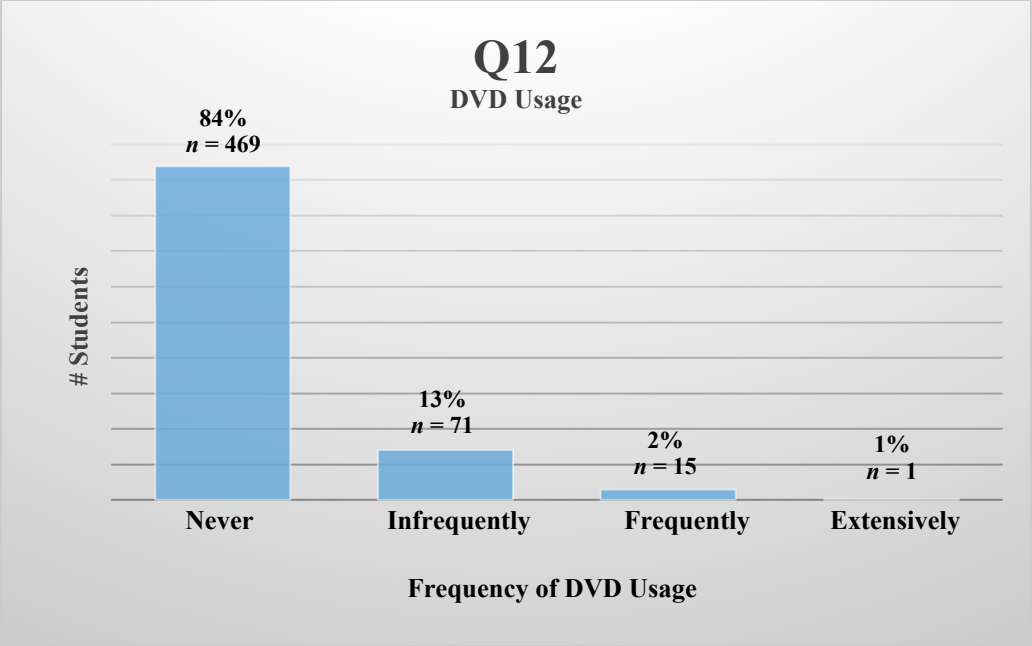

Figure 11. Frequency of DVD usage as study material for human anatomy courses reported by students (n = 556).

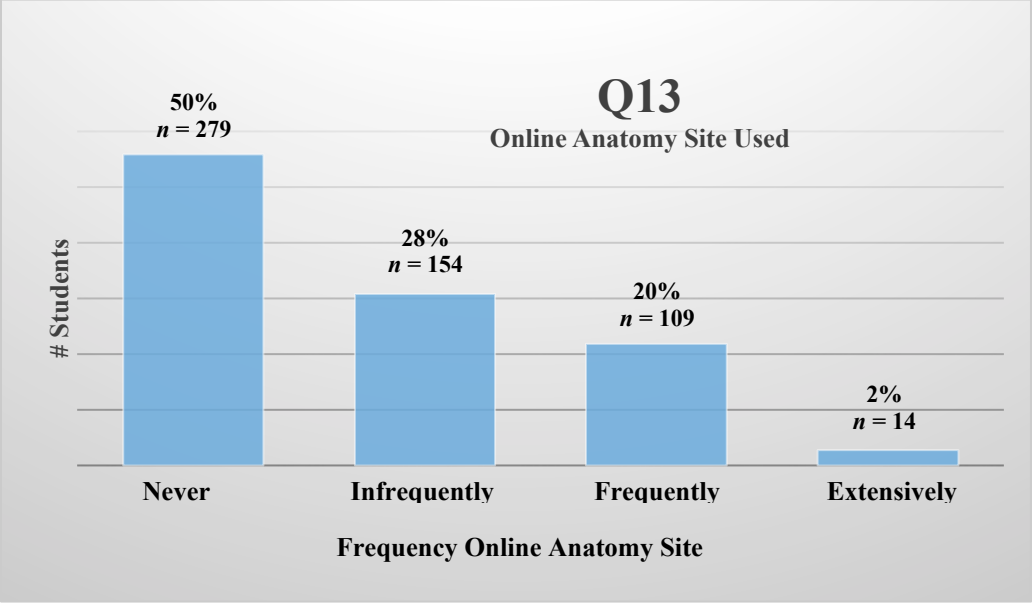

Figure 12. Frequency of visiting online sites to study human anatomy reported by students (n = 556) that include cadavers.

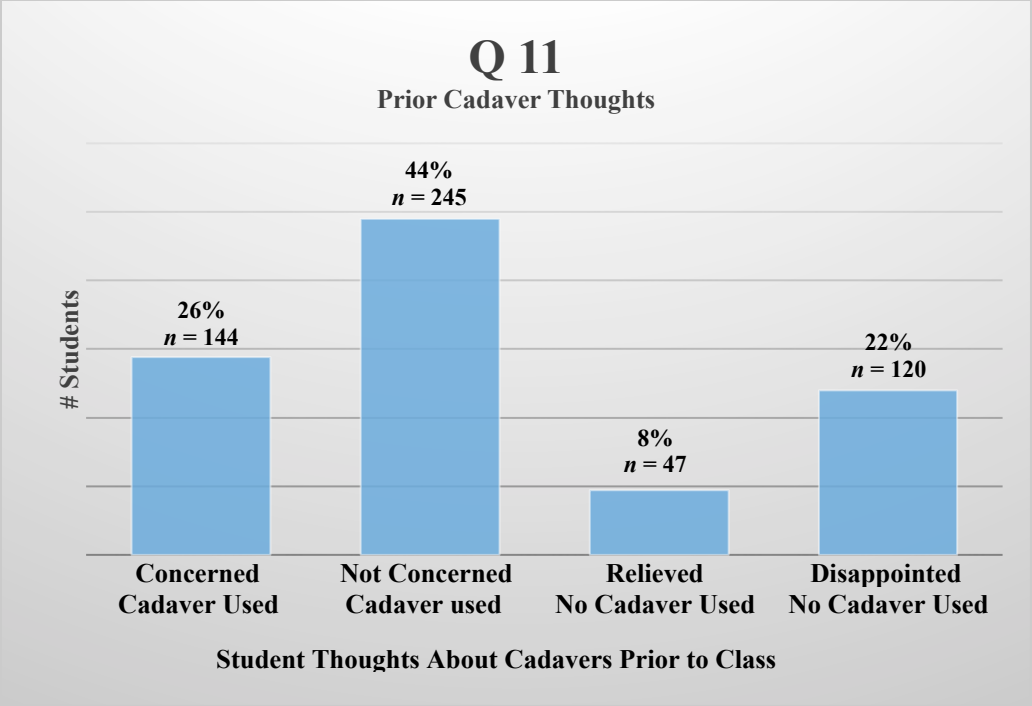

Figure 13. Thoughts of students (n = 556) about cadavers being used or not in class prior to entering their human anatomy course.

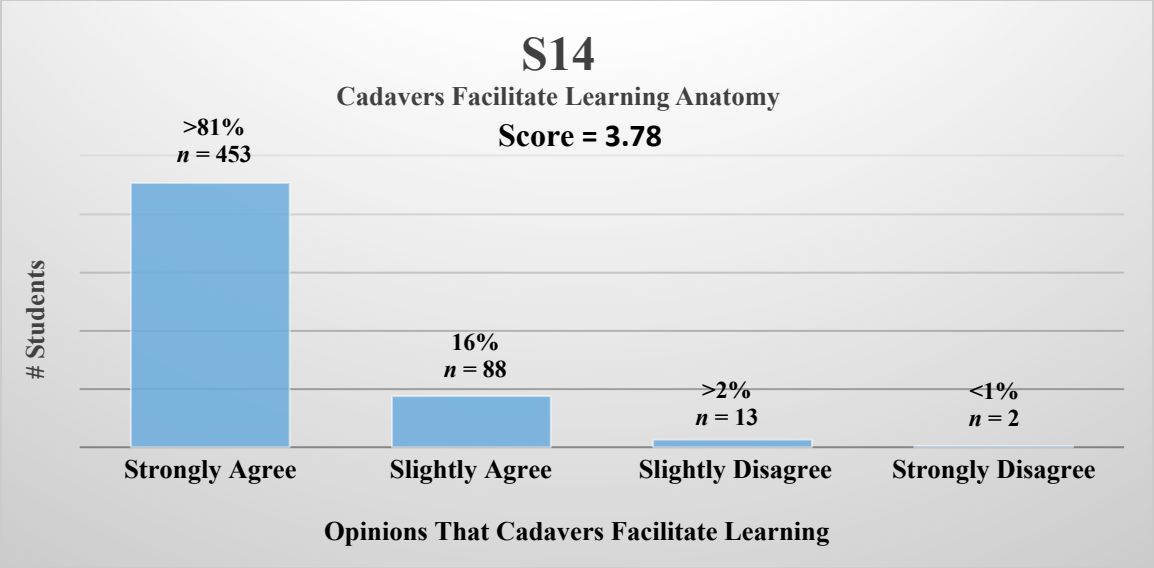

Figure 14. Opinions of students (n = 556) regarding the statement-- the usage of cadavers facilitates the learning of human anatomy.

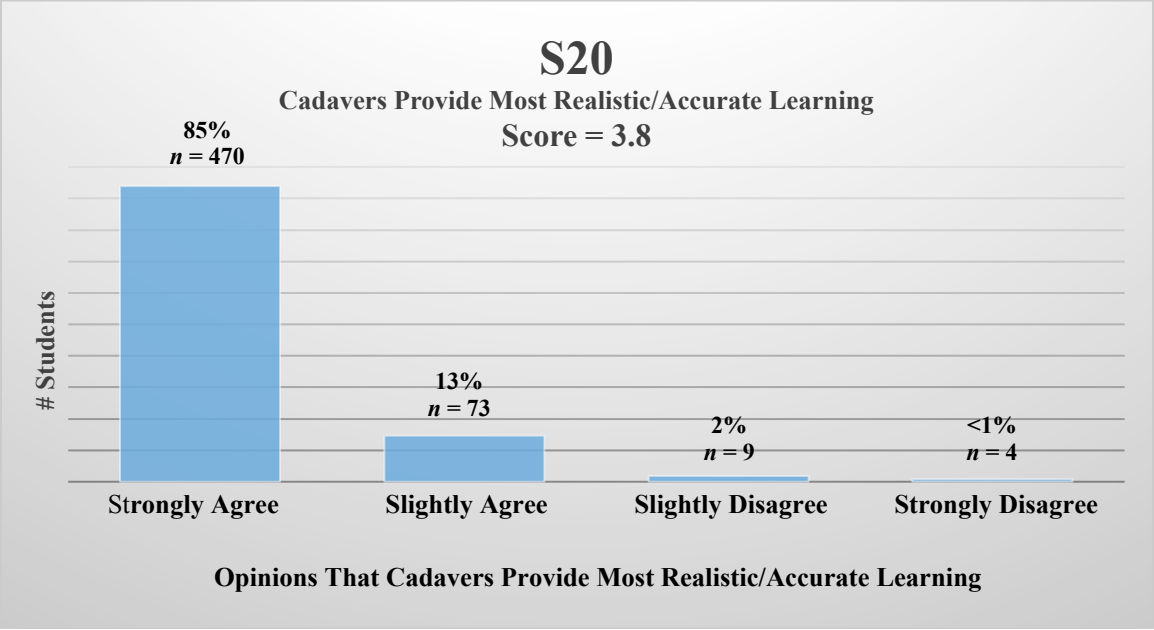

Figure 15. Opinions of students (n = 556) regarding the statement-- the usage of cadavers in human anatomy class would provide the most realistic/accurate understanding of the human body.

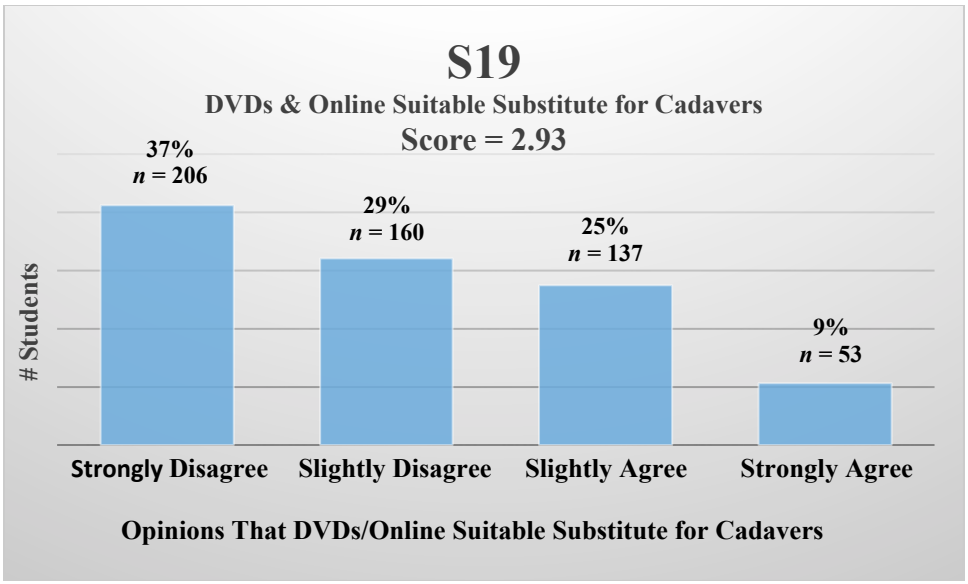

Figure 16. Opinions of students (n = 556) regarding the statement-- DVDs and online cadaver related resources are suitable replacements for cadavers in classrooms.

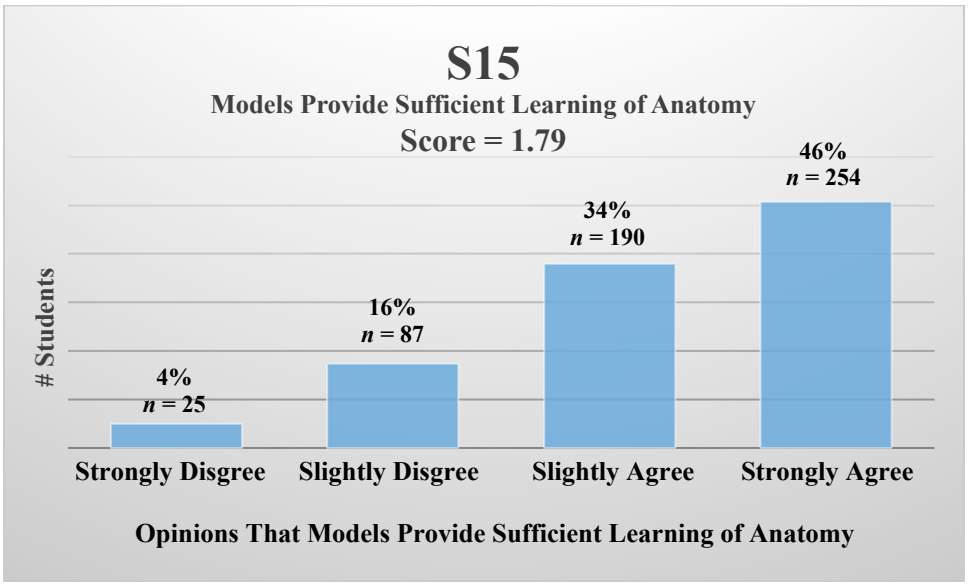

Figure 17. Opinions of students (n = 556) regarding the statement-- models provide sufficient learning of human anatomy.

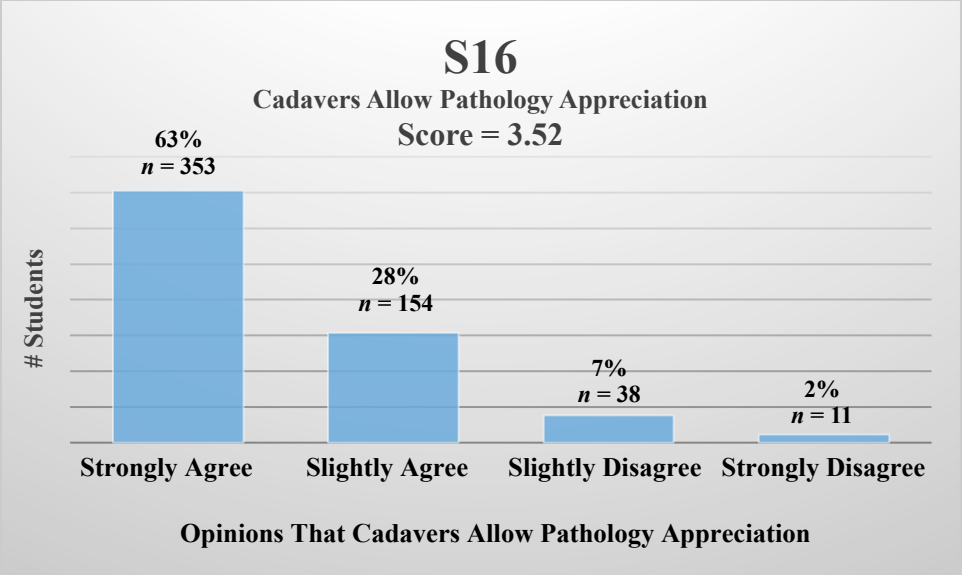

Figure 18. Opinions of students (n = 556) regarding the statement-- cadavers allow better appreciation of pathology- such as obesity and cancer.

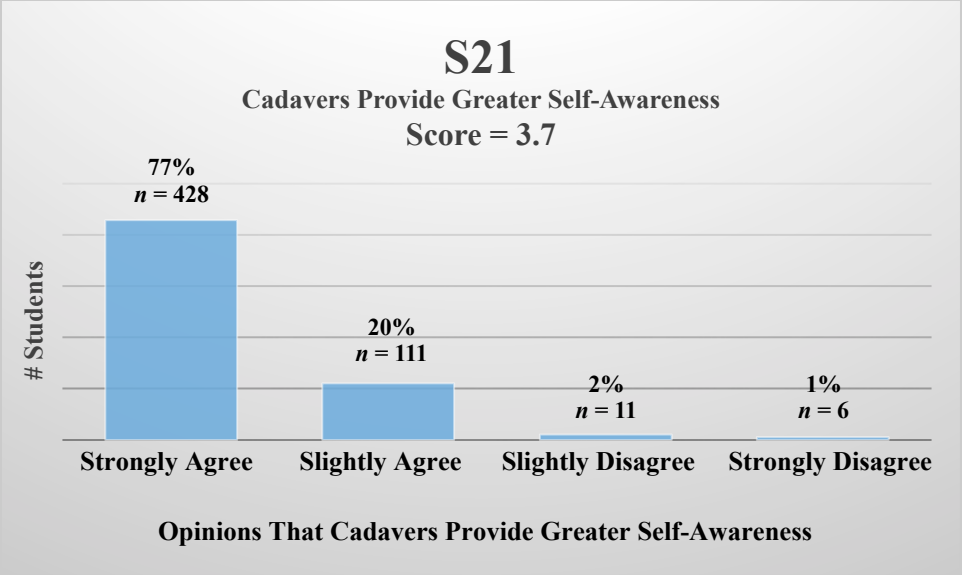

Figure 19. Opinions of students (n = 556) regarding the statement-- cadavers provide a greater self-awareness of one's body.

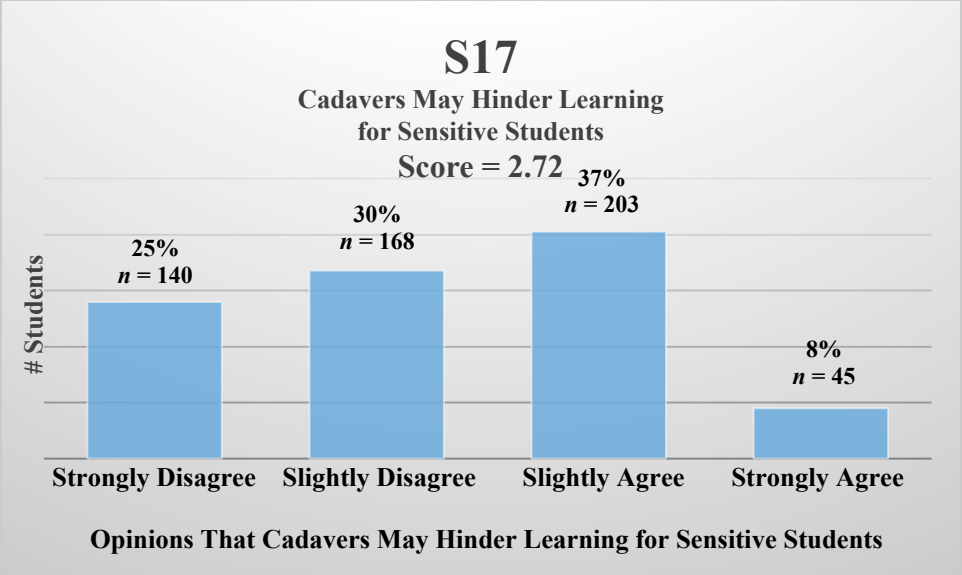

Figure 20. Opinions of students (n = 556) regarding the statement-- cadavers may hinder the learning for students sensitive to viewing a cadaver.

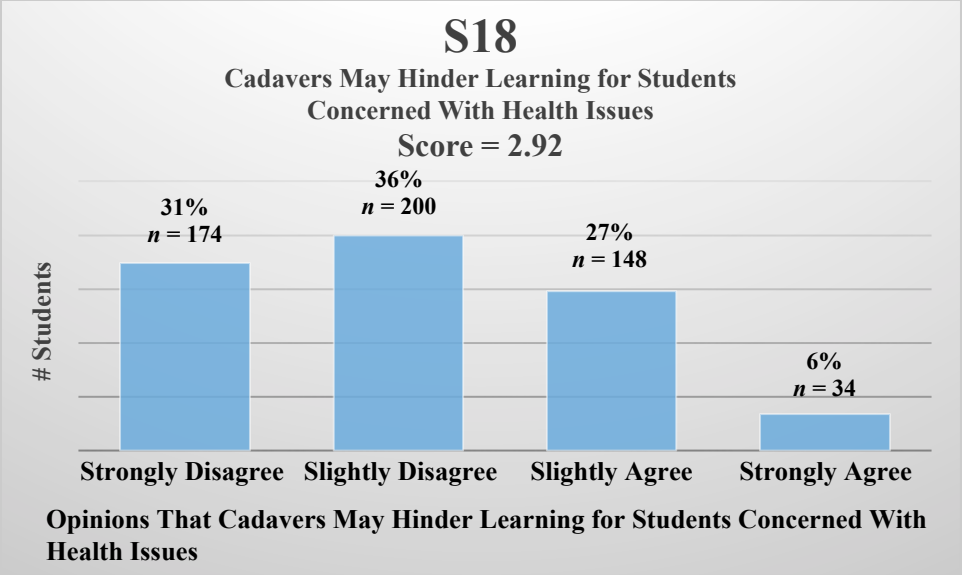

Figure 21. Opinions of students (n = 556) participants regarding the statement--cadavers may hinder the learning for students concerned with health issues related to the use of cadavers.

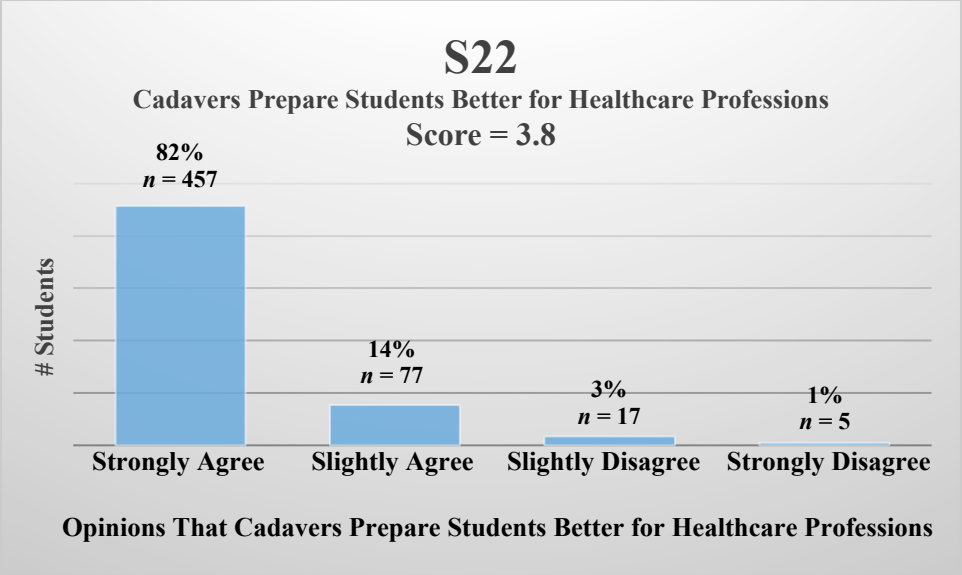

Figure 22. Opinions of students (*n* = 556) regarding the statement-- cadavers prepare students better for healthcare professions.

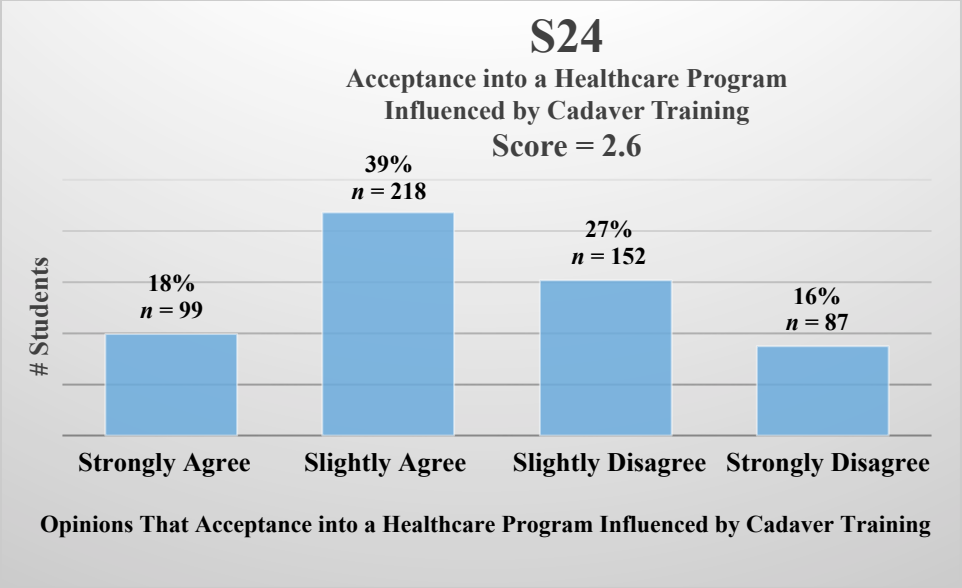

Figure 23. Opinions of students (n = 556) regarding the statement-- acceptance into a healthcare program could be influenced by cadaver training.

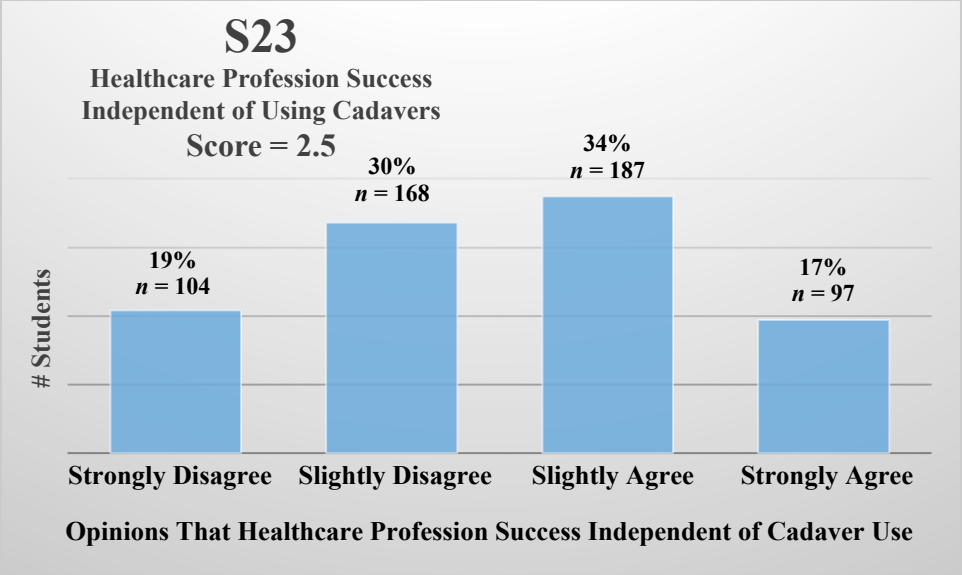

Figure 24. Opinions of students (n = 556) regarding the statement-- healthcare profession success is independent of using cadavers in class.

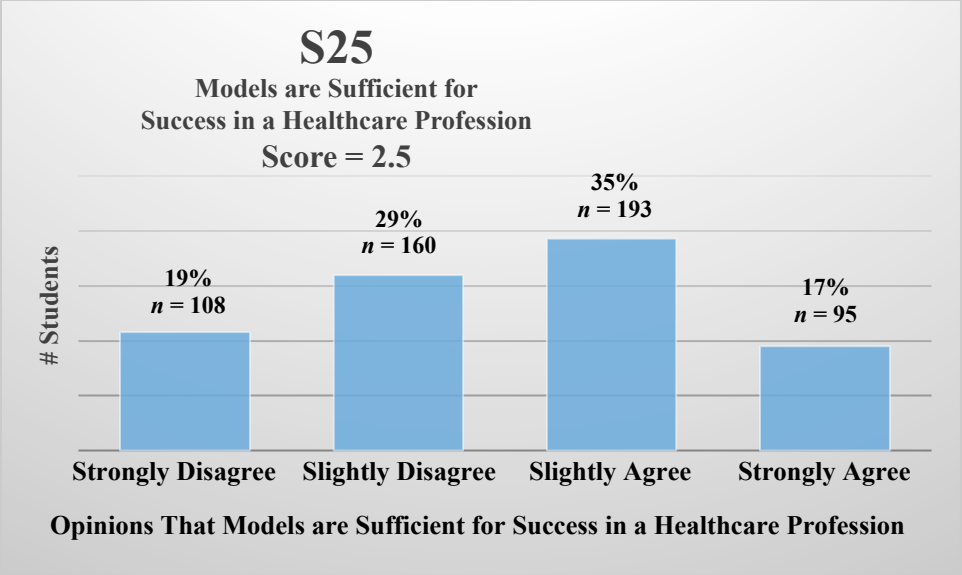

Figure 25. Opinions of students (n = 556) regarding the statement-- models are sufficient for success in a healthcare profession.

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APPENDIX A

UCO IRB REVIEW DOCUMENTATION: Waiver of Informed Consent

If you are granting either a waiver of informed consent or a waiver of some or all of the elements of the required informed consent procedure [45 CFR 46.116(d)], you must document the following:

	Check one.
1. The research in its entirety involves no greater than minimal risk.	☒Yes ☐No
2. The waiver of consent will not adversely affect the rights and welfare of the subjects.	☒Yes ☐No
3. It is not practicable to conduct the research without the waiver/alteration.	☒Yes ☐No
4. Whenever appropriate, subjects will be provided with additional pertinent information after their participation.	☒Yes ☐No

If you answered Yes to all of the above, provide a brief description of the reason(s) the waiver is necessary. The introduction to the questionnaire states: "this is completely anonymous as I am not going to record your name at any time". With an informed consent, the participants would have to give us their name. Also, it states that if they do not wish to participate, they may turn in the questionnaire along with the blank answer sheet. No sensitive data is being obtained.

Check which of the following applies:

☒ The entire consent is being waived

☐ Only certain required element(s) are being waived (list these):

If a waiver is granted, the IRB will still require that subjects are provided with some form of information about the research. Indicate which of the following it will be:

☐ Written information sheet/summary

☒ Verbal explanation

☐ Other (specify)

IRB # 15137

Reviewer: [signature] Date: 9/13/2013

Form Revised 5/17/10

APPENDIX B

B.1 Questionnaire

B.2a Cadaver Photos

B.2b Model Photos

B.3 Answer Sheet

Appendix B.1

Questionnaire **PLEASE DO NOT MARK ON QUESTIONNAIRE, ONLY ON ANSWER SHEET**

1. What is your age?
A) Under 18
B) 18 – 19
C) 20 – 21
D) 22 – 24
E) Over 25

2. What is your current classification?
A) Freshman
B) Sophomore
C) Junior
D) Senior
E) Graduate

3. What is your sex?
A) Female
B) Male

4. What is your ethnicity?
A) Asian
B) Black/African American
C) Hispanic
D) White (Non-Hispanic)
E) Other
F) Prefer not to answer

5. Which best describes your human anatomy course?
A) Previously dissected cadavers were used in lab
B) We dissected cadavers in lab
C) No cadavers used, but had cadaver photos
D) No cadavers used and no cadaver photos were used

6. In college, how many gross human anatomy courses have you taken?
A) One
B) More than one

7. Did you take a separate human anatomy course in high school?
A) Yes
B) No

8. Have you taken a human physiology course?
A) Yes
B) No

9. Which best fits the reason you're taking (or took) a human anatomy course?
A) Prepare myself to enter a nursing program
B) Prepare myself to enter another health-related field
C) Use as an elective for a biology degree
D) Personal interest in human anatomy

10. Before attending your college human anatomy class, did you have any prior exposure to cadavers?
A) Yes
B) No

11. Before entering your college human anatomy class, which best describes your thoughts?
A) Knew a cadaver was to be used and was concerned about how I would react to viewing the cadaver.
B) Knew a cadaver was to be used, but was not concerned about how I would react to viewing the cadaver.
C) Knew a cadaver would not be used and was relieved I would not be viewing a cadaver.
D) Knew a cadaver would not be used and was disappointed I would not be viewing a cadaver.

For questions 12 and 13, choose from the following answers:

A) Never used
B) Infrequently used
C) Frequently used
D) Extensively used

12. Which selection best describes your use of human anatomy DVDs that use cadavers?

13. Which selection best describes your use of online human anatomy sites that use cadavers?

For questions 14 through 25, choose from the following answers the selection that best reflects your opinion:

A) Strongly agree
B) Slightly agree
C) Slightly disagree
D) Strongly disagree

14. The usage of cadavers facilitates the learning of human anatomy.

15. Models provide a sufficient learning process of the human body.

16. Cadavers provide a better appreciation of pathologies – such as cancer and obesity.

17. The usage of cadavers may hinder the learning process for students that may be sensitive to viewing a cadaver.

18. The usage of cadavers may hinder the learning process for students concerned with possible health issues related to the cadaver.

19. Human anatomy DVDs/online would be a suitable substitute for using a cadaver in class.

20. The usage of cadavers in human anatomy classes would provide the most realistic/accurate understanding of the human body.

21. The use of cadavers in human anatomy classes could provide a student with a greater self-awareness of their body.

22. The use of cadavers in human anatomy classes better prepares a student for a healthcare profession.

23. Your success in a healthcare profession is independent of whether or not your human anatomy course used a cadaver.

24. There is a possibility that acceptance into a nursing program or other healthcare professions could be influenced by whether a cadaver was used in a human anatomy course.

25. A model-based human anatomy course is sufficient for success in a chosen healthcare profession.

Appendix B.2a


Cadaver Photo 2
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2
3
Superficial head muscles
Anterolateral view


Cadaver Photo 3
15
14
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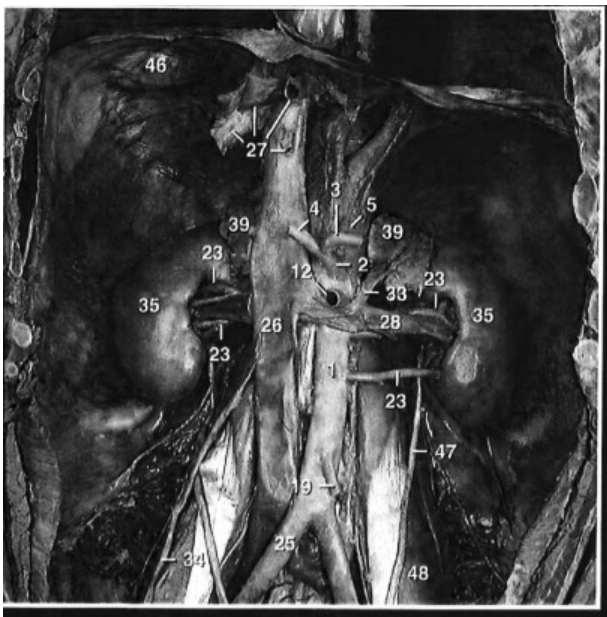
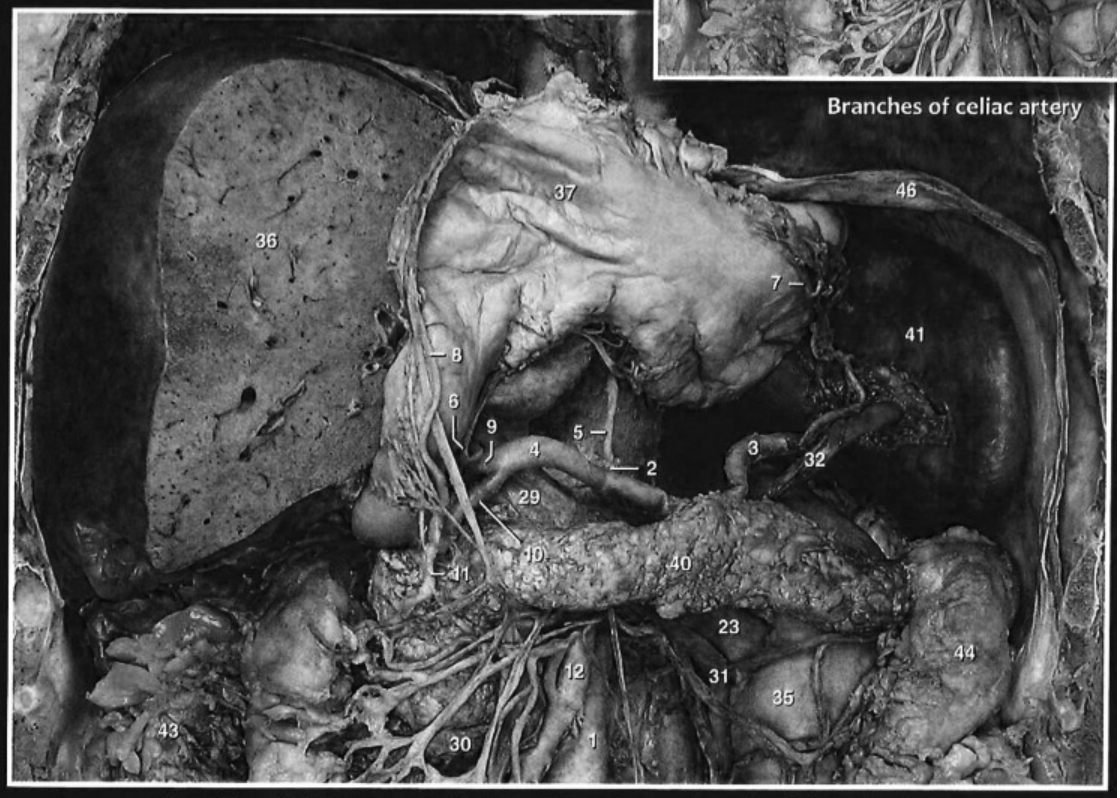
Superficial muscles of the right antebrachium

Cadaver Photo 4



Deep dissection of abdomen showing renal vessels
Anterior view

Branches of celiac artery



Dissection of abdomen showing celiac branches and supply of foregut viscera
Anterior view, stomach reflected upward


Cadaver Photo 5
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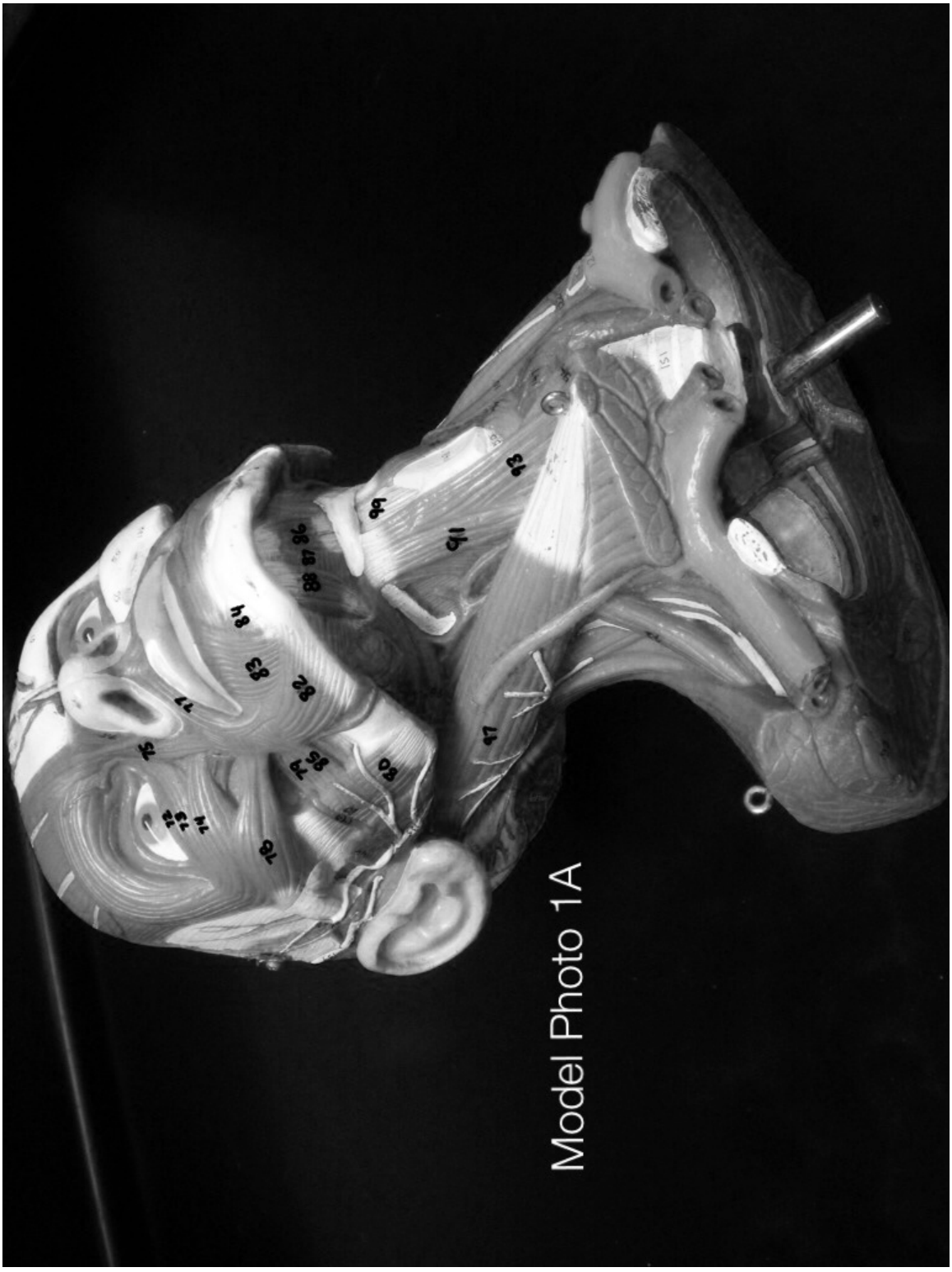
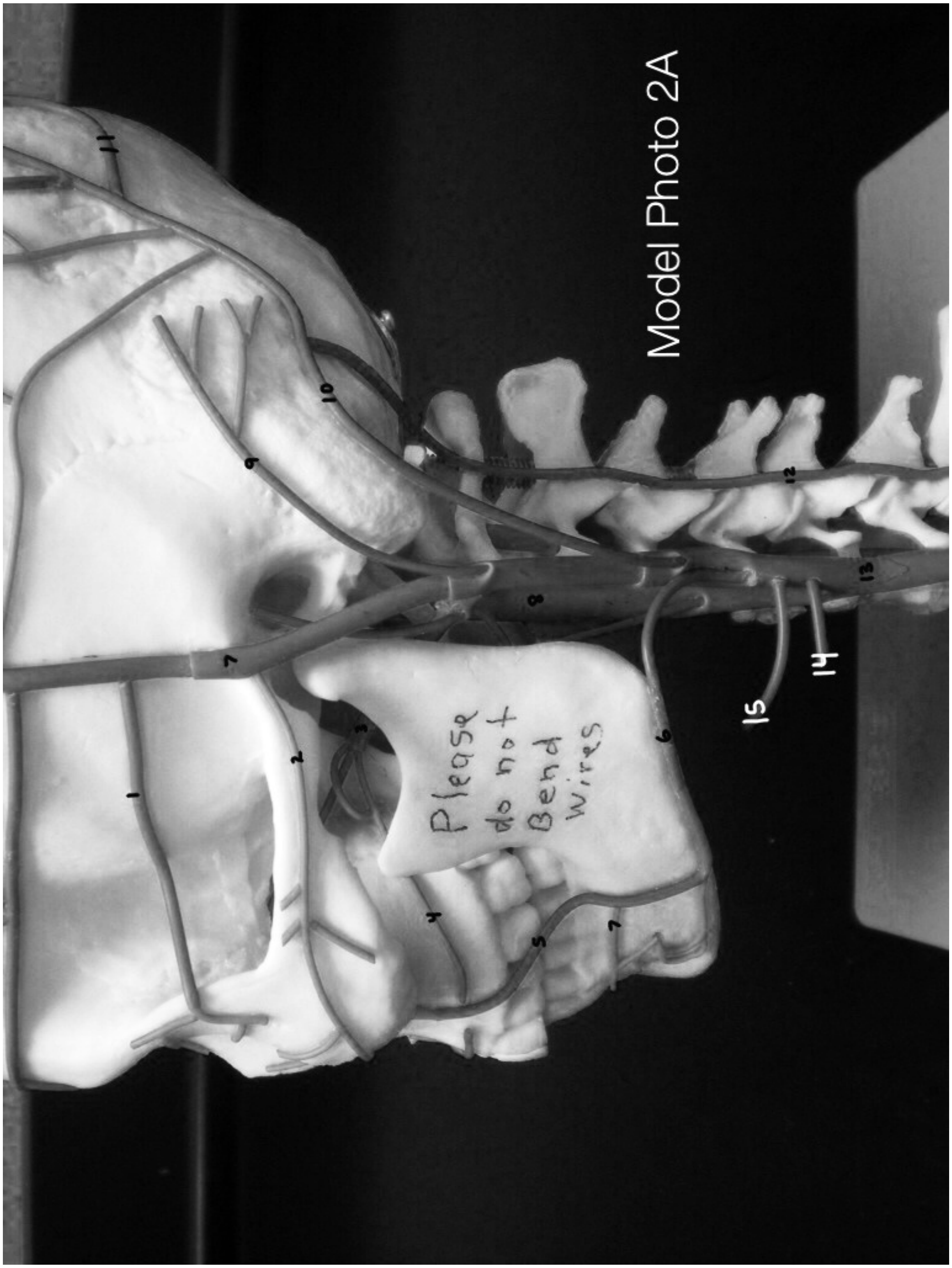
Appendix B.2b




Model Photo 2A
Please do not Bend wires
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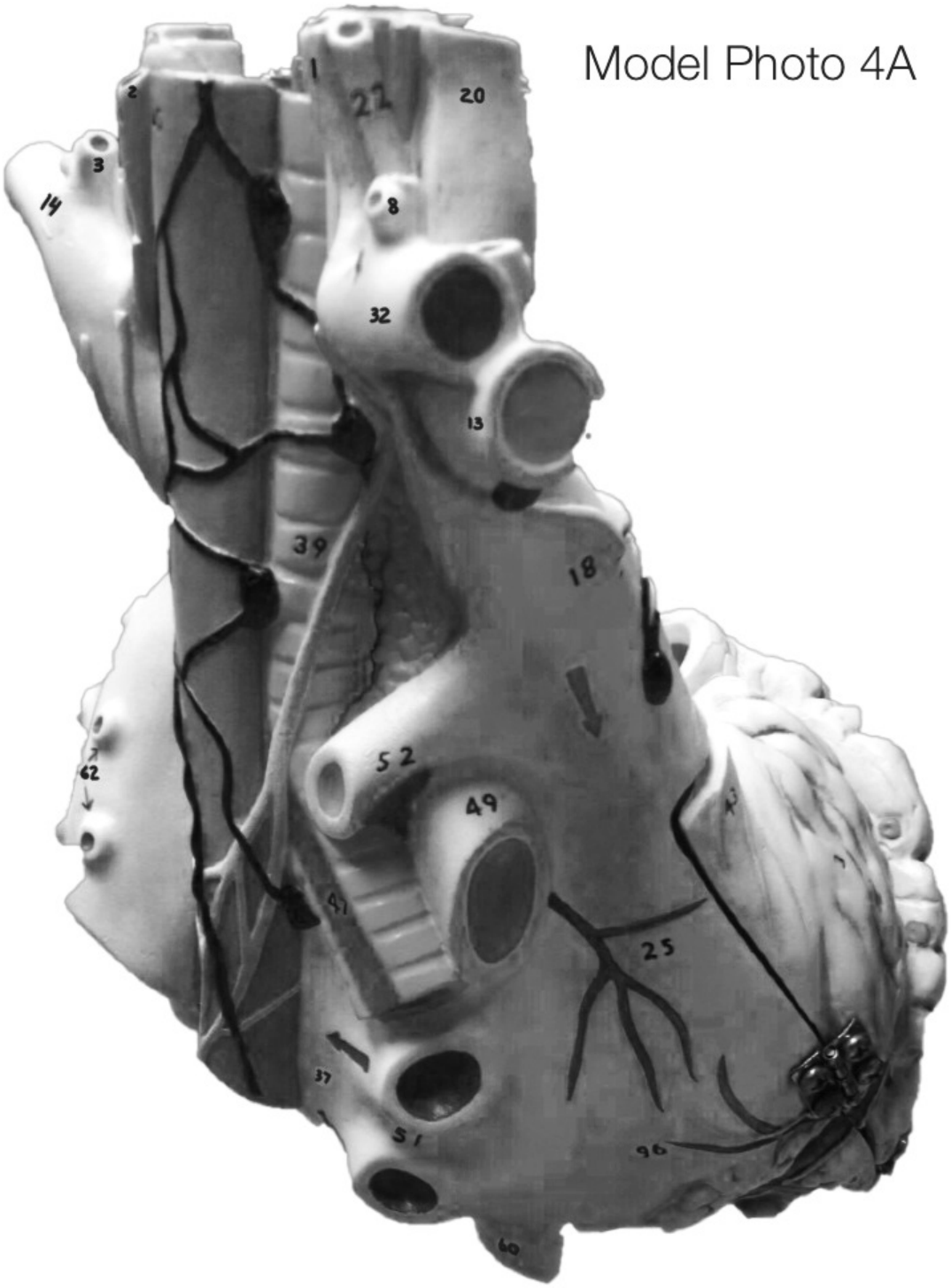
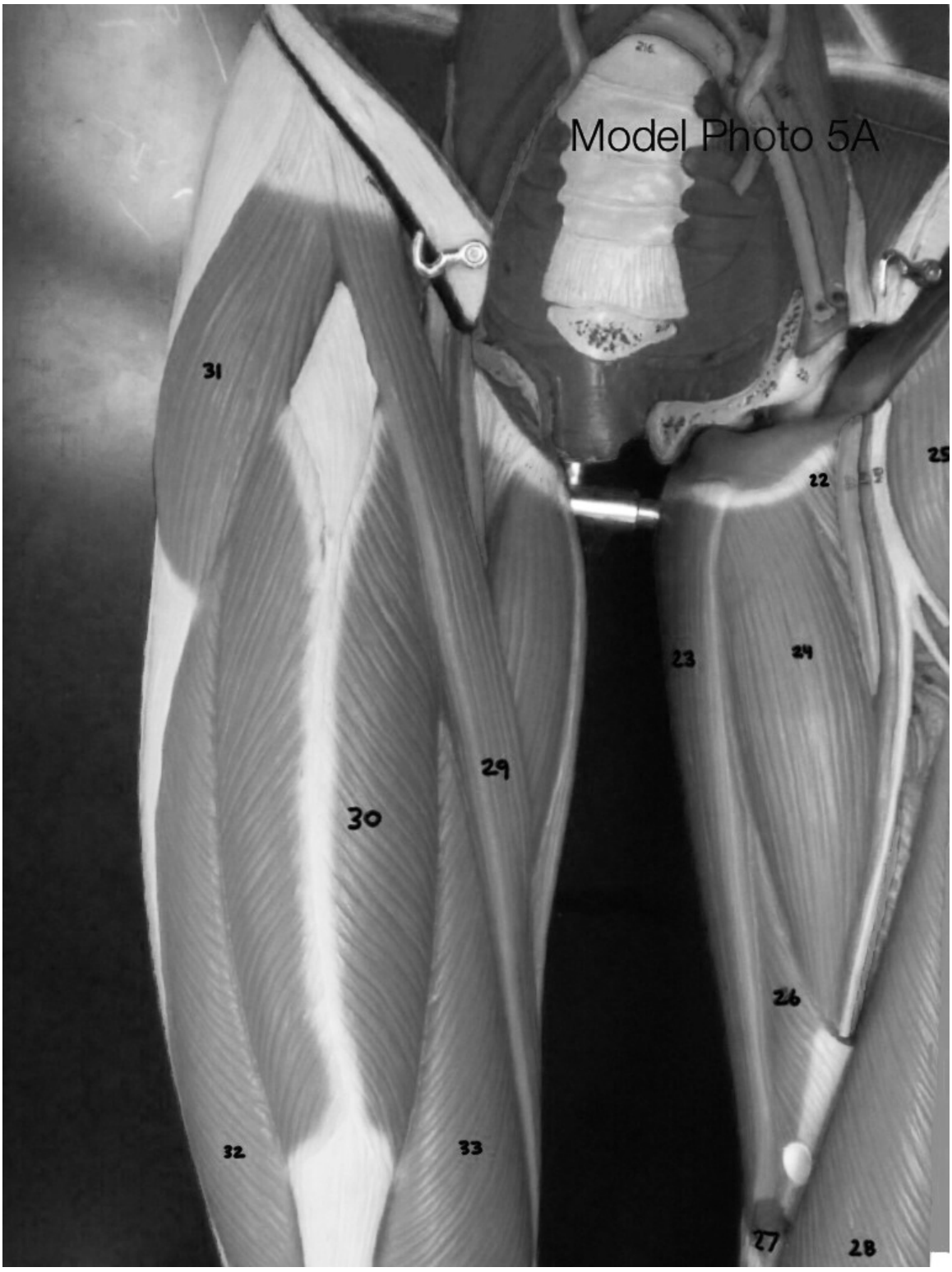
Model Photo 4A




Model Photo 5A
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Appendix B.3

Questionnaire Introduction

My name is Steve Smith. I am a master's student at The University of Central Oklahoma and this questionnaire is my research project. This is completely anonymous as I am not going to record your name at any time. I would appreciate your participation; however, if you do not wish to fill out this questionnaire, just return the questionnaire without this answer sheet. This project has IRB approval from The University of Central Oklahoma and your institution. IRB contact information: Dr. Richard Sneed; Director of Research Compliance; University of Central Oklahoma; 405-974-5479.

Answer Sheet

1) _____ 6) _____ 11) _____ 16) _____ 21) _____

2) _____ 7) _____ 12) _____ 17) _____ 22) _____

3) _____ 8) _____ 13) _____ 18) _____ 23) _____

4) _____ 9) _____ 14) _____ 19) _____ 24) _____

5) _____ 10) _____ 15) _____ 20) _____ 25) _____

Cadaver Photos (1-5)

For cadaver photo #1, what number is the Facial Nerve? _____

For cadaver photo #2, what number is the Buccinator muscle? _____

For cadaver photo #3, what number is the Extensor pollicis brevis? _____

For cadaver photo #4, what number is the Superior mesenteric artery? _____

For cadaver photo #5, what number is Teres major? _____

Model Photos (1A-5A)

For model photo # 1A, what number is the Digastric muscle? _____

For model photo # 2A, what number is the Occipital artery? _____

For model photo #3A, what number is the Pronator teres? _____

For model photo #4A, what number is a Pulmonary vein? _____

For model photo #5A, what number is the Iliopsoas muscle? _____