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Analysis of Graded Gross Anatomy Dissections and Demonstrations as a Supplemental Educational Tool

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Analysis of Graded Gross Anatomy Dissections and Demonstrations as a Supplemental Educational Tool

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Teaching and assessment modalities for human anatomy curriculums vary between schools. The University of Nebraska Medical Center utilizes an integrated gross anatomy lab curriculum including hands-on dissection, lecture, and 3-D models. The GCBA 909 course, Human Gross Anatomy Lab, just recently incorporated graded dissections and demonstrations into their master of medical anatomy (MMA) curriculum. Students were required to complete and demonstrate eight additional dissections compared to physician assistant (PA), physical therapy (PT) students. Upon completion of these dissections, students were assessed based on the quality of their dissections and were also required to demonstrate the cadaveric dissections to anatomy faculty members. This study compared the assessment and course grades of the 2016 MMA students to the PA and PT students enrolled in GCBA 909 Fall 2016 as well as the 2015 MMA class enrolled in the course Fall 2015. Students then participated in one of two focus groups and completed a survey. Qualitative results displayed that the majority of students had a positive opinion about the additional dissections and demonstrations; however, the quantitative results showed no statistically significant correlation between the additional dissection and demonstrations and the 2016 MMA students' unit practical exams and overall course grade.

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scored higher on all unit exams and total course grade compared with the other students. Unit 4 exam average grades are significantly higher for all class cohorts except for the MMA 2015. The MMA 2015 class compared with MMA16 class had similar scores, about 1 grade point higher on unit two and three, but lower on unit 4. The MMA 2015 also had less variance between the grades than did the MMA16 students.

This figure displays the number of MMA students who had this type of self-reported anatomy background. 3 MMA students had previously been undergraduate teaching assistants. 6 MMA students learned anatomy using pre-dissected human cadavers. 3 MMA students performed dissection on human cadavers. 4 MMA students performed dissection on cats. 1 student did not perform dissection and reported to have learned anatomy using 3-D plastic models. Of note, one student reported to have dissected both a human cadaver and a cat.

These survey results were completed by all 15 MMA students evaluated. Notably, most students self-reported that they felt that the additional dissections and demonstrations were beneficial with an average score of 4.73 (dissections) and 4.67 (demonstrations).

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Chapter 1: Introduction

Gross Anatomy is one of the most important courses taken by students studying health professions. Teaching styles in anatomy vary from school to school, and the techniques are refined according to which teaching method is accepted as most effective and suitable for the student population. There are multiple journals that focus on the study of anatomy education such as Clinical Anatomy, Medical Teacher, and Anatomical Sciences Education. It is vital to study the best anatomical teaching approaches because of how fundamental this course is to students in health professions. Gross Anatomy itself holds an unparalleled importance in health sciences education.

There are differing opinions regarding the best teaching method for anatomy, but the overall usefulness of cadaveric dissection has been accepted in multiple studies. These studies have shown that gross anatomy dissection promotes professionalism, emphasizes teamwork, helps develop team-based learning and communication, and prepares students for patient care and practical clinical skills. Additionally, cadaveric dissection introduces students to anatomical variations, and an overview of internal human anatomy (Azer and Eizenberg, 2007; Escobar-Poni and Poni, 2006; Fitzpatrick, Kolesari, and Brasel, 2001; Inwood and Ahmad, 2005; McLachlan, Bligh, Bradley, and Searle, 2004; Rizzolo and Steward, 2006).

Students, teaching faculty, and clinicians have agreed in various studies that cadaver dissection has several positive educational benefits (Wojciech, P. and Nirusha, L., 2004). It has been found to be essential to students' understanding of anatomy and lays the foundation for successful clinical skill performance (Davis et al., 2014; Elizondo-Omañ and López, 2008; Iqbal, 2010; Kerby et al.; Patel and Moxham, 2008; Snelling et al., 2003, 2011; Van Wyk and Rennie, 2015). In a recent study, surgeons were asked what they felt was the most useful resource to learn anatomy and the majority of surgeons stated that both dissection and prosection (previously dissected specimens used to demonstrate anatomical structures to anatomy students) were the most useful anatomy education tools. Surgeons from multiple specialties were asked about anatomy education and the study found that regardless of the career stage, dissection and prosections of cadavers were the best anatomical teaching methods. Another benefit of cadaveric dissection, according to surgeons partaking in the same study, is the development of students' familiarity with imaging such as CT, radiographs, ultrasounds, and MRIs (Sheikh, Barry, Gutierrez, O'Keeffe, 2015). In addition to qualitative data showing preference for cadaveric dissection, performance in anatomy courses has also been analyzed using quantitative data such as assessment performance. The results of a study performed by Jones, Paulman, Thadani, and Terracio (2001) showed that students perform better on their practical exams if they have participated in cadaver dissection compared with students who do not. On the other hand, they also found that medical students who dissected in their anatomy course did not show any significant improvement on the National Board of Medical Examiners subject exam which were taken months after the completion of the course (Jones et al., 2001).

To keep up with changing times in education, some schools are altering their curriculum to include cadaveric dissection supplemented with new technology tools such as three-dimensional (3-D) electronic anatomy models which mimics the nature of real anatomical specimens by allowing students to actively visualize the structures by manipulating the view in all dimensions (Peterson and Mlynarczyk, 2016). Some health profession schools in Australia and New Zealand no longer have curriculums that are completely reliant on dissection based anatomy learning. Instead, they include virtual and 3-D models in the course (Craig et al., 2010).

Per Habbal (2009), medical schools are altering their curriculum to be more integrated and clinically applicable. An integrated curriculum, as explained by Vidic and Weitlauf (2002) is one that emphasizes multiple areas of study instead of one that teaches a single discipline. Vidic and Weitlauf (2002) suggest that curriculums that focus on single disciplines rely heavily on detail memorization instead of a true understanding of the material. The impetus behind an integrated and diverse curriculum is to provide the most efficient method of teaching students anatomy while also helping them retain the information in the long term.

It is difficult to quantify the amount of schools that use an integrated curriculum. However, it can be anecdotally accepted from discussion with multiple faculty and online searches that nearly all curriculums utilize an integrated curriculum. Despite most health profession schools using an integrated anatomy curriculum, some schools do not have a cadaveric dissection component. Though nursing school is separate from allied health professions, anatomy education is required so it must also be studied. There appears to be a lack of cadaveric anatomy provided in these schools. For example, there are nursing schools which rely on a heavily surfaced-based approach to anatomy but do not offer any cadaveric dissections in the curriculum (Johnston, 2009). With that being said, it has been shown that offering dissection or prosections in nursing curriculums and health professions studies is beneficial and offers an insight into anatomy beyond the surface (Stansby, 2004; Collett and McLachlan, 2005; Winkelmann, 2007). Despite the fact that nursing is often not categorized with allied health professions, nursing school relies heavily on anatomy. There are several studies that have explored the improvements of nursing education by including cadaveric-based anatomy.

The shift to using multimedia teaching styles has been motivated by several factors including the cost of cadaveric specimens, shortage of qualified anatomists, limited availability of cadaver specimens, and time consuming nature of dissection (Aziz, McKenzie, Wilson, Cowie, Ayeni, and Dunn, 2002; Isbell, Makeeva, Caruthers, and Brooks, 2016; McLachlan et al., 2004). In addition to the logistical reasons, some influences for a shift in anatomical teaching are physical. Students in multiple studies have reported an unpleasant smell, nausea, stress, and mental health issues such as anxiety and depression related to time spent in the cadaver lab (Horne et al., 1990; Aziz et al., 2002, Hancock et al., 2004; Houwink et al., 2004; Agnihotri and Sagoo, 2010). According to a study conducted by Agnihotri and Sagoo (2010), some first-year medical students who have never seen a cadaver before may experience emotional distress including disgust and anxiety simply due to their exposure to cadaveric specimens in the lab. This is a common experience by students who are seeing a cadaver for the first time and is often observed within the first few days in the anatomy course. Some students sit out during the first few dissections because of their moral conflict. Additionally, there have been students who need to excuse themselves from the class during dissection in order to regroup their emotions and physical reactions to cadaveric dissection.

More and more studies over the past fifteen years have begun to show that there is a benefit to using multimedia, radiological, and 3-D model teaching methods for anatomy. A comparison of students taught using a lecture-based teaching style which often uses two-dimensional images and figures and those taught with 3-D multimedia teaching styles showed that students taught using a 3-D curriculum had better assessment results (Nicholson et al., 2006). Although there has been information to support the notion that 3-D anatomy curriculums prepare students for assessments more so than lecture-based curriculum, there has been conflicting results related to gross anatomy lab curriculums. One study showed improvements when using physical laboratory methods such as cadaveric specimens while another reported no difference between multimedia-based teaching and hands-on learning (Codd and Choundhury, 2011; Saltarelli AJ, Roseth, and Saltarelli WA, 2014). Elizondo-Omaña et al. (2004) originally proposed that a combination of both multimedia and dissection-based learning would be the most beneficial for students, so Peterson and Mlynarczyk (2016) evaluated the benefit of the combination of both. They reported a correlation between students' evaluation of the benefit of an integrated curriculum and an increase in assessment performance. A limitation of their study, as suggested in their publication, was that technology "take[s] time and effort to learn," indicating that the students may not have been using the technology to its full potential, suggesting that this type of integrated curriculum needs to be studied more (Peterson and Mlynarczyk 2016, p. 535).

As schools tend to move towards use of more virtual learning systems, in anatomy and other subjects, studies have been exploring the importance of hands-on learning. A study by Kontra C, Lyons DJ, Fischer SM, and Beilock SL (2015), found that physical experiences in science can promote learning by activating sensorimotor brain systems. This study explored hands-on learning in physics classrooms by asking students to participate in physical activities to understand physics topics (Kontra et al., 2015). Additionally, past studies have shown that hands-on learning influence students' education positively despite age. Paris SG, Yambor KM, Packard BW (1998) showed a significant positive correlation between middle-school aged students' attitudes towards science when they participated in hands-on learning activities. They also reported a significant improvement in assessment scores after these hands-on activities (Paris et al., 1998). Hands-on learning is directly related to anatomical dissection. This study's purpose is to analyze whether the hands-on learning of dissection and then demonstration of these dissections to faculty can affect student outcomes quantitatively and qualitatively.

Another useful tool used for teaching gross anatomy lab is the use of a list of terms or checklists that are designed to help guide the students to look for specific anatomical structures. In medical education, checklists are often used for performance-based assessments which are able to evaluate each student according to their knowledge of each term or checklist used. In the gross anatomy lab, checklists or a list of anatomical structures have shown slight (but statistically significant) improvements in students' performance on anatomical practical examinations. The study by Hofer, Nikolaus, and Pawlina (2011) not only examined the quantitative outcome of the students' exam grades, but also found a qualitative correlation that showed that students had a positive outlook on the use of checklists and felt that it increased their performance in the lab as well as teamwork functionality. This study concluded that checklists help students maintain focus in lab which can help students better understand anatomy as it applies to their future careers (Hofer et al., 2011). The reasons behind different curriculum adaptations in anatomy are multifactorial, as previously discussed. Along with a variety of approaches to anatomy curriculums comes different ways of assessing student performance in anatomy courses.

Overview of anatomy laboratory assessment modalities:

Along with the differing opinions in regards to the best teaching methods in anatomy, there is also debate about the most appropriate modalities used to assess each students' work. To best assess students' understanding of gross anatomy laboratory work, students are tested in multiple ways depending on school preference of curriculum (Sugand, Abrahams, and Khurana, 2010; Johnson, Charchanti, and Troupis, 2012). According to Hofstein and Lunetta (2004), students view cadaveric-dissection lab with less importance if they are not required to participate in practical exams. This lack of student dedication to an anatomy course can lead to lower levels of performance. Institutions are trying out new assessment modalities to find what best assists the learning of anatomy students including the relatively new idea of grading dissections. Schools such as the Mayo Medical School, Augustana College, and University of Adelaide have performed trial runs with graded dissections while some schools have already incorporated graded dissections into the gross anatomy lab curriculum. A study by Nwachukwu, Nirusha, and Wojciech (2014) looked at how quality of dissection affected student performance in the gross anatomy course at Mayo Medical School. Students in each laboratory group were expected to participate in the cadaveric dissections and were then graded on the quality of the groups' dissection (worth 5% of final grade). The grades were based on the number of structures in the dissecting list as well as subjective analysis by each evaluator. The grades on the dissections were then compared to student performance on practice practical examinations as well as quizzes formatted to mimic final examination questions. The outcome of the study showed a positive correlation between the quality of dissection and performance on the practice practical, final practical exam, final written exam, and the National Board of Medical Examiners (NBME) gross anatomy and embryology subject exam. It did not, however, show the same correlation on the quizzes which the study attributed to the difference in question type used in the quizzes. Additionally, Nwachukwu et al. (2014) found that students' feedback on surveys at the end of the course were mostly positive regarding the graded dissections; however, it must be noted that only 16% of students thought grading dissections was valuable to the course. The positive feedback reported by Nwachukwu et al. (2014) displayed students' positive outlook on the dissection in regards to their experiences. However, even if the students felt that the graded dissections were useful, most students did not believe it to be the most valuable component of the course as a whole. The study did not follow this up by asking students what the most valuable component of the course was.

Curriculums for gross anatomy use assessment modalities such as tests, quizzes, quality of dissection, evaluations (self and peer), and unique assessments per school policy. There is an array of assessments used in higher education often categorized as either summative or formative. Formative exams can be either formal or informal and are used to monitor the progression of students' performance throughout a course (Brookhart, 2009). Summative assessments can also be either formal or informal, but are used to measure a students' competence in an area of a course or the course as a whole. Formal summative assessments including practical examinations and cumulative final examinations have long been used to assess student competence of a subject. Summative assessments are used in most curriculums, however the use of formative assessments varies (Azzi, Ramnanan, Smith, Dionne, and Jalali, 2014; Black and William, 1998; Brookhart, 2009). Formative assessments are often given by educators who wish to track students' performance throughout a course (Heritage, 2007). The study by Azzi et al. (2014) showed that anatomy students with the opportunity to complete various types of formative assessment performed better on summative assessments relative to students who did not participate in any form of formative assessment.

The Azzi et al. (2014) study was performed to analyze the benefit formative examinations have on summative exams given in anatomy courses. Summative exams are described as "high stake" such as practical exams or cumulative final examinations. The study found a statistically significant, but modest, correlation between the students' performance on the quizzes and the practical examinations. The most significant finding was the correlation between the students performing poorly on the formative exams and practical exams. These students who were performing poorly on the quizzes (formative assessments) were more likely to perform poorly on the practical exams (summative assessments). Additionally, it was found that the midterm examination, which is described in this study as a type of formative assessment, correlated more with the practical exams (summative assessments) than did the quizzes that were given throughout the course. The study suggested that a reason for this interrelationship was that the exams and midterm exams tested similar knowledge, while the quizzes were formatted and meant to test different information (Azzi, Ramnanan, Smith, Dionne, and Jalali, 2014; Black and William, 1998; Brookhart, 2009). It has been suggested that, in general, tests which assess higher order learning, such as midterms, have a higher correlation to the final examinations than do quizzes, which often Krasne, Wimmers, Relan, and Drake, 2006).

Past studies about anatomical education display a variety of the best teaching methods and assessment modalities. Studies have explored whether cadaveric dissection by itself or with technological supplements is more beneficial and have gotten conflicting results. Some say that cadaveric dissection is most important, while others argue that it does not play a more beneficial role in health science education. Along with differing opinions on anatomy teaching styles, there is also the aforementioned discussion about what the most effective assessment modality is. Therefore, research that explores and analyzes the correlation between grading cadaveric dissection and performance on practical examinations provides valuable data regarding preparation and success on both formative and summative assessments in gross anatomy.

This study aims to fill the gaps regarding the use of assessing cadaver dissection and demonstration of each students' understanding of an anatomy topic. The students analyzed in this study participated in an integrated anatomy curriculum which heavily focuses on cadaveric dissection guided by a list of terms in an electronic interactive dissecting guide which allows students to click on specific anatomy terms in order to visualize the structure. As previously discussed, there has been a study which compared quality of dissection with student outcomes in a gross anatomy course (Nwachukwu et al., 2014), but there is little studied in regards to how graded dissections of a particular anatomy topic affect student outcomes on related practical examinations. This study specifically investigated whether or not there is a correlation between student performance on eight graded dissections and demonstrations and their performance on practical examinations testing related material. Fifteen Master of Medical Anatomy (MMA) students completed eight additional dissections when compared to their physician assistant, physical therapy, and doctoral of each dissection to evaluating professors who assigned them a grade according to a rubric. There were two dissections and demonstrations per unit and each dissection and demonstration will be compared to the performance on the related unit practical exam. Additionally, this study gained qualitative feedback from students in order to assess the outlook students have on grading dissections and related demonstrations. A major goal of this study was to evaluate the usefulness of assessing dissections and demonstrations as a supplemental tool for anatomical education. To assess the effect of the additional dissections and demonstrations, practical examination grades from MMA students this year who participated in this addition to the curriculum were compared to students from the previous year who did not have additional dissections and demonstrations. Additionally, MMA students who participated in the additional dissections and demonstrations were invited to complete surveys and participate in a focus group to assess the students' qualitative feedback. Studies have explored different anatomy teaching and grading styles, but there is very little research in regards to an integrated curriculum that grades students' quality of dissections and requires them to demonstrate their work. The purpose of this analysis is to fill some of these gaps within the present literature and explore how grading dissections and demonstrations may help to improve anatomical education. We hypothesize that these additional dissections and demonstrations will have a positive impact on the MMA 2016 (MMA16) students' performance on each unit exam and total course score when compared with MMA students in 2015 (MMA15), Physician Assistant (PA) students in 2016 (PA16), and Physical Therapy (PT) students in 2016 (PT16). Qualitatively, we hypothesize that if the MMA16 students participate in these additional dissections and demonstrations, then they will have a positive opinion of this curriculum for the MMA program.

Chapter 2: Methods

Study Design

This study analyzed grades, surveys, and focus group feedback from 15 master of medical anatomy (MMA) students who were enrolled in Gross Anatomy Laboratory (GCBA 909) during the Fall semester of 2016 from August to December 2016. The study was approved by the International Review Board and was given the exemption status (IRB# 844-16-EX). There are no known risks to participants. Data was obtained between January and March 2017. All necessary information for this study was kept anonymous and secured. UNMC GCBA faculty redacted any identifying information before giving information to myself (Stephanie Cummings) to analyze data. At the completion of the course, all 15 MMA students were invited to participate in the study and were required to sign a consent form (Appendix A) before any data collection began. Students were invited to participate in a survey and one of the two focus group sessions. After the focus group sessions, students were invited to complete a survey addendum.

Course Format

During the Fall 2016 semester, laboratory groups of two MMA students per one cadaveric donor were selected at random. There were initially 16 MMA students, but one student left the program, leaving 15 MMA students to partake in this study. One MMA student was partnered with the PhD student enrolled in the course. This PhD student was required to complete the additional dissections, but is not included in this study. Though the MMA, PA, and PT students were enrolled in the same course, the course numbers were different. MMA students were enrolled in GCBA 909 while the PA and PT students were enrolled in the course number

GCBA 571. This course required the MMA, Physician Assistant (PA), Physical Therapy (PT), and PhD student to perform each dissection listed in the dissection guide. After the completion of the required dissections for each unit, students were required to participate in a practical examination for each unit. These practical examinations were set up using standard practical methods. Practical examinations were set up with one pinned anatomical structure on each cadaveric donor. The students were placed one student per donor table and given one minute to answer the question regarding the pinned structure. After the end of this minute, an alarm signaled students to move to the next station. Students were never allowed to return to any table after the completion of the test so that each student was allowed the same time per station (one minute).

The 15 MMA students were required to complete eight additional dissections with their anatomy laboratory partner, then asked to present these dissections to faculty members for a grade. The last dissection, sole of foot, was dissected by every student (PA16, PT16, and MMA16), but only the MMA16 students received a grade for this dissection. Each unit had between 1 and 3 required additional dissections and associated demonstrations (Table 1.1).

Unit	**Table 1.1: Additional Dissection(s) and Demonstration(s)**		
1	Back and vertebral column	Joints of upper limb	
2	Pterygopalatine fossa	Larynx	
3	Inguinal canal		
4	Perineum	Hip and knee joints	Sole of foot

Table 2.1: Dissections and Demonstrations MMA students participated in during the associated unit.

Approximately a week before each unit exam, students had a designated time where they were required to demonstrate each identifying anatomy structure listed in the dissection guide list of terms to an anatomy faculty member. Each demonstrator was given a total of five minutes per dissection demonstration. The students were graded using a rubric (Appendix B) included in the syllabus given at the beginning of the Fall 2016 semester.

There were two dissections (back and vertebral column and larynx) that were dissected by both students, but only presented by one of the two partners. The demonstration presented by one student was assigned a grade that was given to both lab partners. The six other additional dissections were completed by both students and the demonstrations were completed by all 15 MMA students. These dissections were suggested to be completed outside of the laboratory period due to the time constraints of the scheduled lab periods. Demonstrations were set up with one student per one faculty member. The students were required to demonstrate each structure on the list of terms with a time limit of 5 minutes for each dissection.

Survey and Focus Group

The students who were eligible to participate in the survey and focus groups were MMA students who were enrolled in GCBA 909 during the Fall 2016 semester. The survey and focus groups were designed to gauge students' perspective regarding additional graded dissections and demonstrations, analyze whether the students had a positive or negative outlook on the curriculum, and provide any feedback they deemed fit for future students. A total number of 15 students participated in the surveys. There were 6 students during the first focus group and 9 in the second focus group. At the beginning of the meeting, students were asked to complete a consent form, then invited to participate in a survey (Appendix C). At the completion of the survey, students were asked a series of prepared questions (Appendix D). The focus group sessions remained anonymous and were not coded per individual participants. Dictations of each focus group were documented by and only accessible by myself. Additionally, students were later invited to complete a survey addendum (Appendix E). All 15 students completed this survey addendum.

Data Analysis

After compiling the quantitative data, statistics were used to interpret the significance of the information. The data involving the MMA 2016 students alone was not normally distributed, so the Kruskal-Wallis nonparametric test was used. ANOVA was used to assess the statistical significance of the relationships between all class cohorts including MMA16, MMA15, PA16, and PT16. After ANOVA, Tukey's post hoc test was performed to assess the relationships between each student class.

Individual unit exams were also assessed based on questions that were associated to the dissections and demonstrations and those that were unassociated to the dissections and demonstrations. The MMA16 student class was analyzed on an individual basis by comparing the percent correctly answered associated questions compared with correctly answered unassociated questions. Fifteen PA16 and fifteen PT16 students who scored similarly to the MMA16 students, on average, were selected at random to be analyzed. These tests were also assessed comparing percent correctly answered associated questions and correctly answered unassociated questions. This data was used to see how the students who had not completed the extra dissections (PA16 and PT16) scored compared with the MMA16 class.

Qualitative data obtained via a survey, survey addendum, and focus groups were analyzed by calculating the percent students who agreed or disagreed with each statement. The surveys utilized the Likert-type scale ranging from 1 (strongly disagree) to 5 (strongly agree). The focus groups were transcribed and analyzed for common themes that were found throughout both focus groups. In addition to these common themes, the transcriptions were examined to find any data that was uncommon throughout both focus groups as well as statements that were reiterated multiple times by several focus group participants.

Chapter 3: Results

There were four units that concluded in a practical examination after the completion of each dissections. All students enrolled in the GCBA 909 course including MMA, PA, PT, and PhD students participated in each practical examination. 15 MMA students completed 8 additional dissections and demonstrated these to the GCBA professors. In the beginning of the semester there were 16 MMA students, but one student dropped from the program; thus, 15 MMA students enrolled in Fall 2016 were analyzed. The purpose of this study was to identify any correlations between grading dissections/demonstrations with the overall performance on each exam and whole course. Both quantitative and qualitative data was obtained in order to include an assessment of student perceptions of the requirement of graded dissections/demonstrations. Below is the list of required additional dissections and demonstrations that 15 MMA students completed along with the average unit exam grades. Of note, the dissection and demonstrations were assessed together, providing one grade for both.

The MMA students received grades for the dissection and demonstration where they presented the terms from each dissection. The average grades for each dissection and demonstration was compared with the average exam grade. Notably, the average exam grade for unit four is 9.91% higher than the second highest average exam grade for unit 2. Additionally, unit 4 contained three additional dissections and demonstrations and has two average dissection grades of 100.00%.

TABLE 3.1: MMA ADDITIONAL DISSECTIONS AND DEMONSTRATIONS

Unit	Additional Dissection and Demonstration	Average Dissection Grade	Average Exam Grade
1	Back and vertebral column	98.63%	75.07%
	Joints of upper limb	97.22%	
2	Pterygopalatine fossa	96.97%	76.58%
	Larynx	96.88%	
3	Inguinal Canal	98.94%	76.03%
4	Perineum	100.00%	86.49%
	Hip and knee joints	98.75%	
	Sole of foot	100.00%	

Table 3.1: Each unit had at least one dissection and demonstration that the MMA students were required to participate in. This table shows the average scores on the dissection/demonstration for the students as well as the average unit exam for the MMA16 students.

The graded additional dissections and demonstrations contributed a total of 80 points to students' final grades (10 points per additional dissection and demonstration). With the addition of the additional dissection and demonstration points added, there was an average increase in the lab grade of 4.56%. On average, MMA16 students scored 82.26% in the GCBA 909 course.

Evaluation of each unit exam included analyzing associated questions and unassociated questions. First, the number and percent of questions associated with the required additional dissection and demonstrations that the MMA students performed was calculated. The number of associated questions on the exam was compared with the total number of exam questions to calculate the percentage of associated questions on each unit exam. Listed below in Table 3.2 is the number of questions associated with the additional dissections and demonstrations on each unit exam.

TABLE 3.2: ASSOCIATED QUESTIONS ON UNIT EXAMS

UNIT	Number of Associated Questions	Number of Total Exam Questions	Percent of Associated Questions per Number of Exam Questions
1	13	60	21.67%
2	9	75	12%
3	8	70	11.43%
4	27	65	41.54%

Table 3.2: Each unit had a designated number of questions associated with the additional dissections and demonstrations that MMA students completed. The percentage of associated questions on each unit exam is calculated to be: Exam 1 – 21.67%, Exam 2 – 12%, Exam 3 – 11.43%, and Exam 4 – 41.54%.

Each unit included anywhere between 8 and 27 questions associated with the additional dissections and demonstrations each MMA student was required to complete. Unit 3 exam is notable to include the lowest percent of associated questions with only 11.43% of associated questions per total number of exam questions, though it is only 0.57% difference from unit 2. Unit 4 had the highest percent of associated questions being 41.54% of the total exam questions. Unit 4 did include three additional dissections, while unit 3 only had one additional dissection in the curriculum.

Student Performance

A goal of this study was to analyze whether grading dissections and demonstrations had an impact on unit assessment scores and overall course grades. Unit 1 analysis includes only six MMA student scores because this test was not photocopied and stored. Five exams were kept for Unit 1 exam. To obtain all 15 exams for unit one, an e-mail was sent out to the 15 MMA requesting the first examination to be analyzed, but only 1 was returned. After Unit 1, faculty began photocopying and storing examinations for the remaining units. The information from Unit 1 is included in this study, but is noted to be more limited due to the smaller sample size assessed. The number of missed terms associated with the additional dissections and demonstrations was compared with average exam score for each unit.

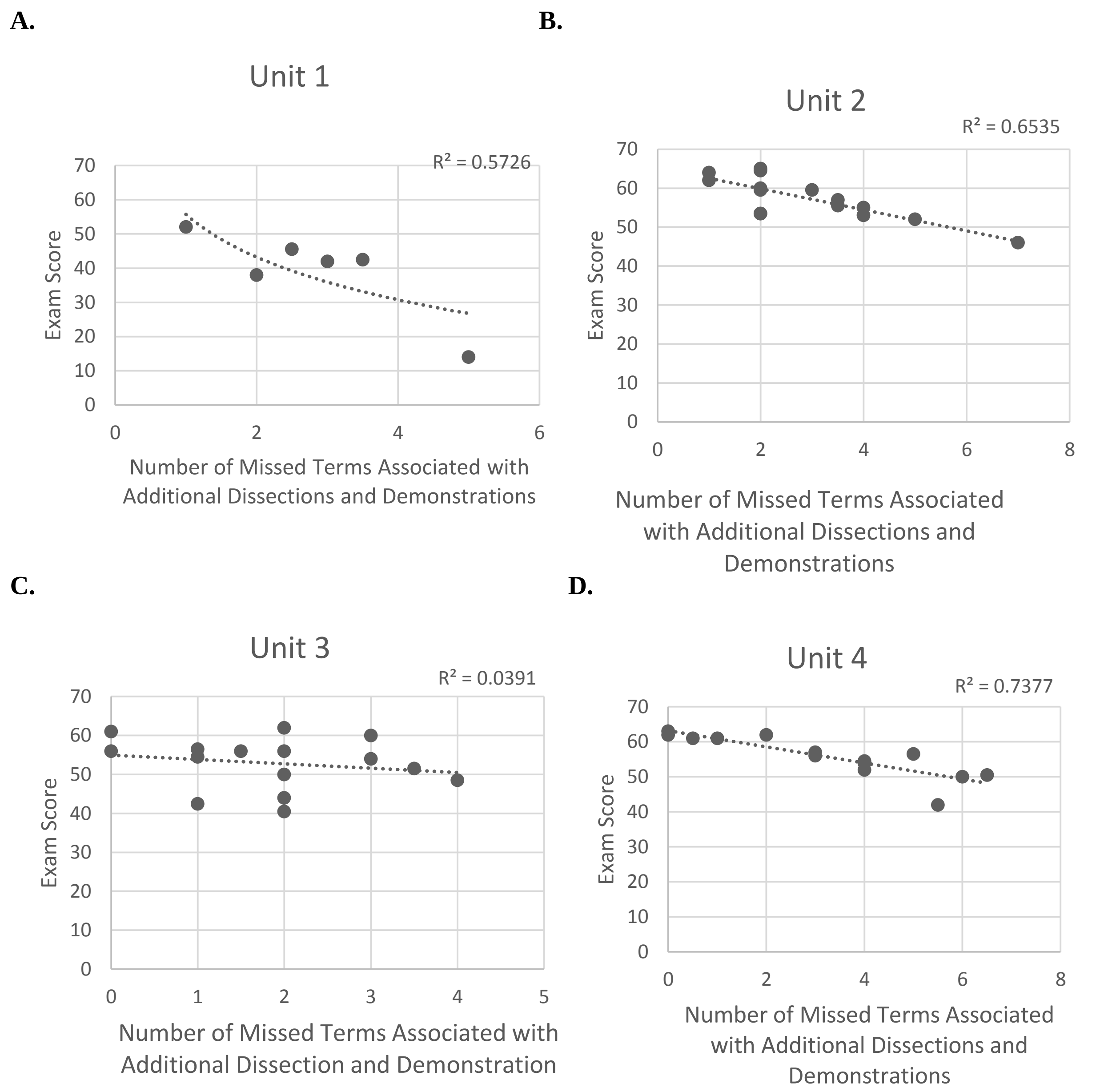


Figure 3.1: Number of missed associated terms compared to total number of correct answers on each unit exam. A.) This figure shows data from 6 MMA students (n=6). This data displays R^2 value of 0.5726. B.) This figure shows data from 15 MMA students (n=15). This data displays R^2 value of 0.6535. C.) This figure shows data from 15 MMA students (n=15). This data displays R^2 value of 0.0391. D.) This figure shows data from 15 MMA students (n=15). This data displays R^2 value of 0.7377.

Unit 1 exam has an extra limitation when compared with the other units because it only includes 6 total MMA students. The R^2 value was calculated to be 0.5726, showing very little correlation between each students' grades. The R^2 value for unit 2 is slightly higher at 0.6535. Unit 3 had the lowest R^2 value of 0.0391 suggesting that there was essentially no correlation between the incorrect associated terms and the correct exam score when compared to the others. This is notable when compared to the number of associated terms on the unit exam. Unit 3 had the lowest number of associated terms compared to other units with the total test including only 11.43% of questions (terms) associated with the additional dissections and demonstrations. Unit 4 has the highest R^2 value of 0.7377 which suggests the strongest correlation between the exam scores and number of incorrect questions directly related to the additional dissections and demonstrations. About forty-one percent of the Unit 4 exam was made up of questions associated with the additional dissections and demonstrations that the MMA students completed; the highest percentage of related material compared to the other three unit exams. More notable than the individual R^2 values is the difference range of the values – 0.0391 to 0.7377. Unit 3 has an R^2 value that is 0.6986 smaller than the R^2 value for unit 4. This data was assessed for normality and found to not be normally distributed.

Students who missed less associated terms were predicted to have a higher score on their exam as shown in the above data. However, this study's goal is to assess whether the additional dissections and demonstrations have a positive effect on exam scores. The percent of correctly answered questions associated with the additional required dissections and demonstrations was compared to the percent questions correct from the rest of the exams (Figure 3.2). Each unit was assessed separately and displayed a common trend of students performing higher on the associated dissection questions than questions not associated with the additional dissections.

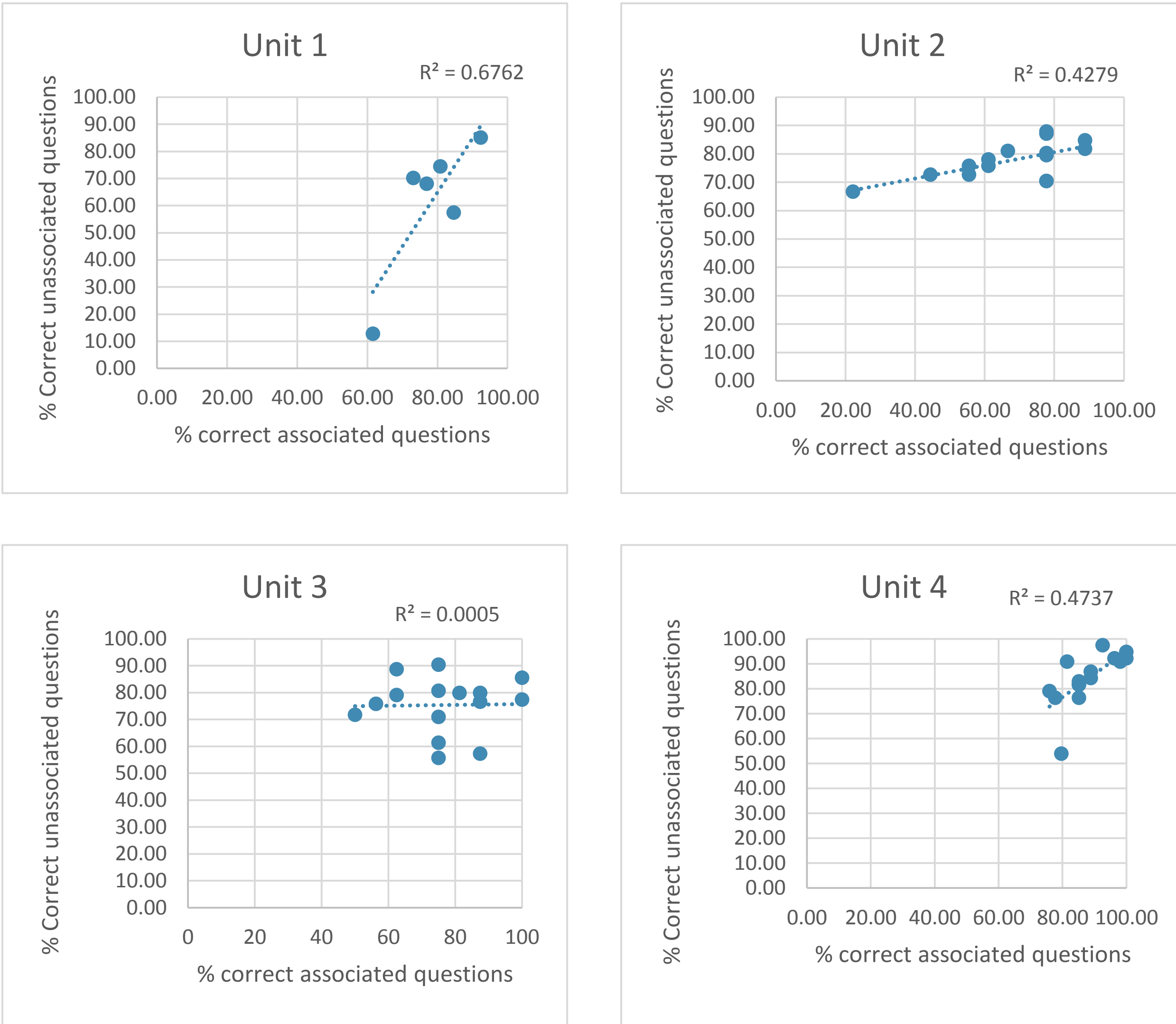


Figure 3.2: Relationship between percentage of correctly answered questions associated with the additional dissections and demonstrations and the percentage of correctly answered questions associated with the other exam questions. Kruskal-Wallis nonparametric test was performed and resulted in p-values that are not statistically significant for all four unit exams.

On Unit 1 five of the six students analyzed performed better on the associated questions compared with the unassociated questions. On unit 2, there were four out of fifteen students who scored higher on associated questions. Ten out of fifteen students scored higher on associated questions in Unit 3. Lastly, twelve out of fifteen students performed better on the associated questions than the unassociated questions on the Unit 4 exam. Individual MMA16 students were analyzed on each unit exam to evaluate for trends (Figure 3.3).

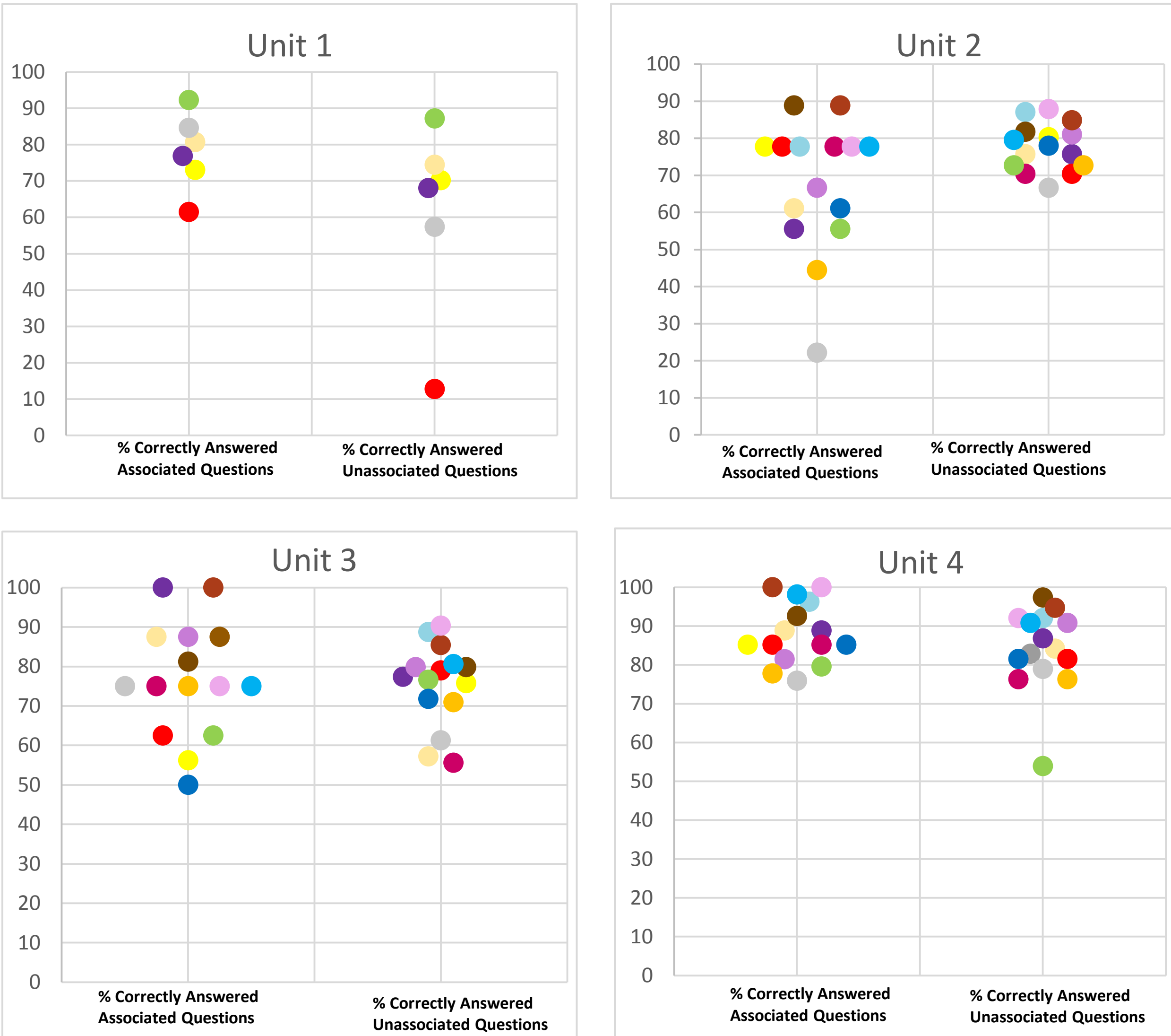


Figure 3.3: MMA16 students were compared on an individual basis comparing their percent correctly answered associated questions to their percent correctly answered unassociated questions. Each color represents one of the fifteen MMA16 students.

PA16 and PT16 students' performance on associated and unassociated questions were then analyzed. PA16 and PT16 students did not participate in the additional dissections or demonstrations, but did learn the information using prosections. Thus, the exams that the PA16, PT16, and MMA16 took in GCBA 909 or GCBA 571 were identical. Figure 3.4 displays PA16 and PT16 performance on the associated and unassociated questions.

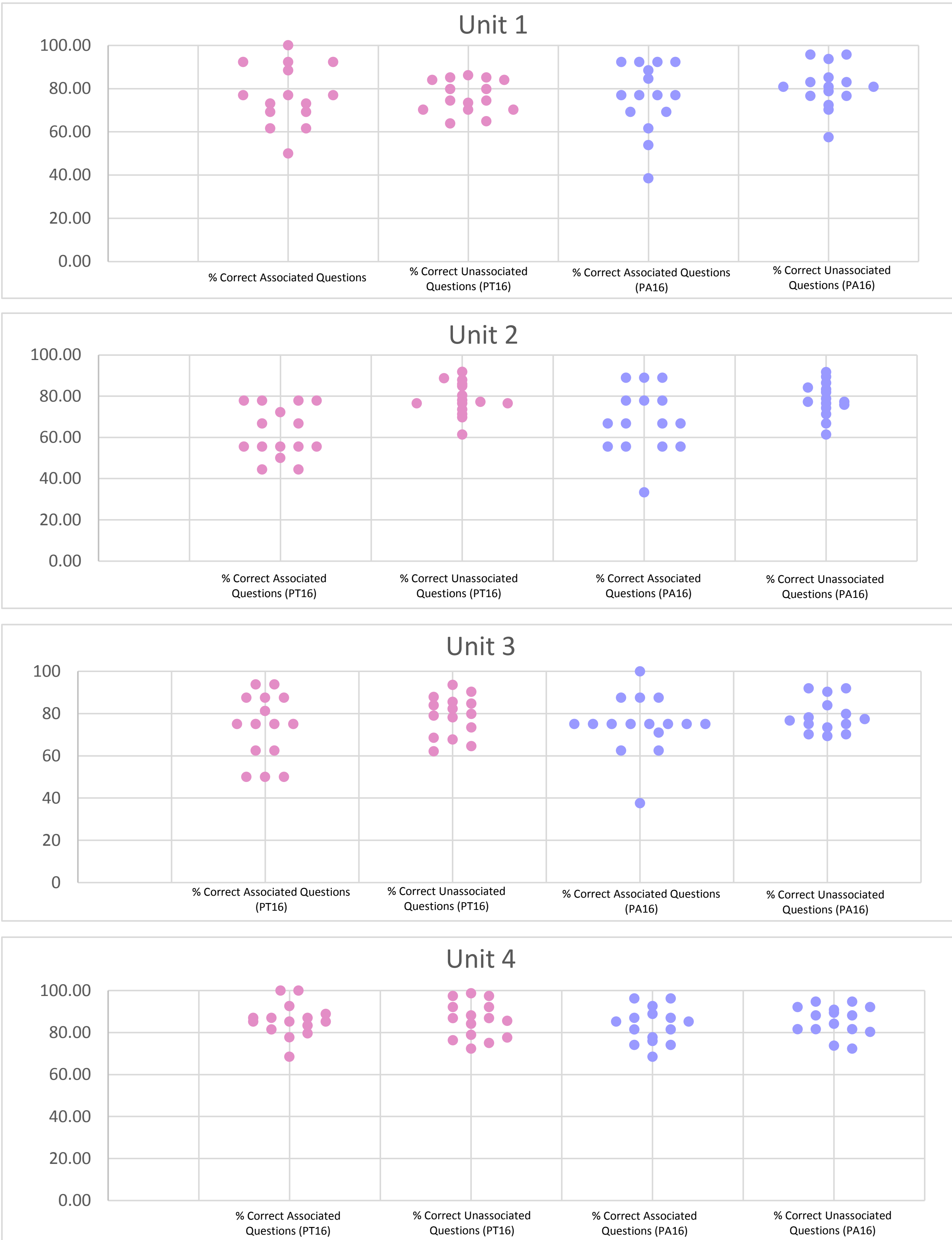


Figure 3.4: PT16 and PA16 students' performance on associated and unassociated questions for each unit were compared. PT16 is designated by pink markers. PA16 is represented by purple markers.

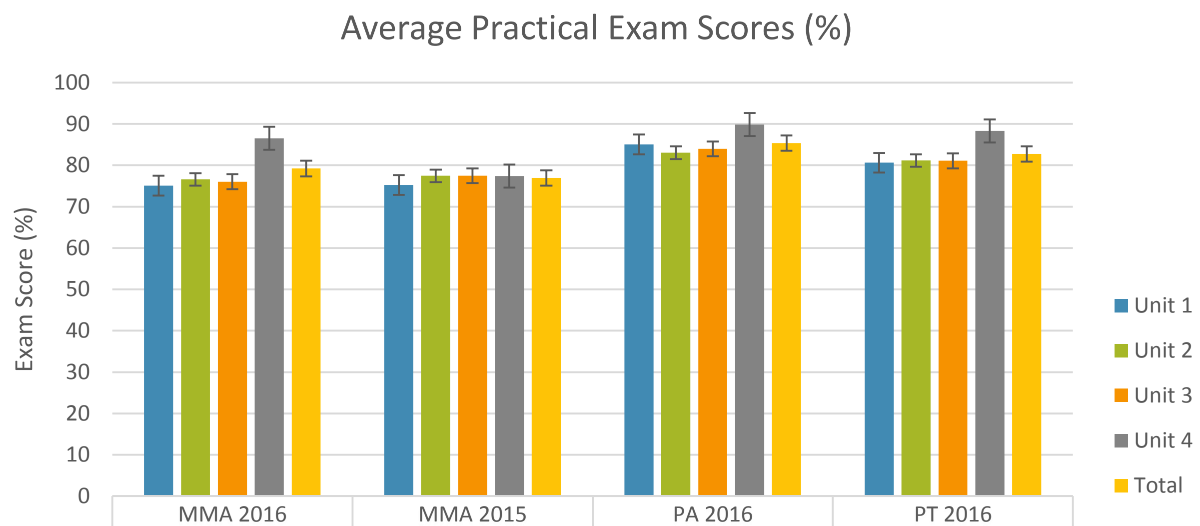
PT16 students, overall, performed better on the unassociated questions than the associated questions on Unit 1 and Unit 2; however, the students performed similarly on the associated and unassociated questions during Unit 3 and Unit 4. PA16 students, on average, performed similarly on the associated questions and unassociated question or all four unit exams.

In addition to analyzing the unit exam grades on a question basis for each unit, the scores were also compared with that of other classmates and class cohorts. Fall 2016 MMA student data was compared with Fall 2016 PA, PT, and Fall 2015 MMA students. This data was compiled by comparing average scores on each unit exam as well as the average course score.

The MMA15 and 2016 classes had the same number of participants (15), but did take the course one year apart from one another and had different teaching and grading faculty. The students had tests that were written by different faculty members and did not include the same number of questions. The MMA15 class did, however, complete the same dissection that are a part of the GCBA 909 curriculum, but completed different additional dissections and did not demonstrate or receive a grade for these. The MMA15 students only had three additional dissections which were back and vertebral column, infratemporal fossa, and inguinal canal. Both years took the same courses outside of gross anatomy including Anatomy Science Journal Club, Clinical and Research Experiences, Professional Opportunities Seminar, and Gross Anatomy Lecture.

The PA16 and PT16 completed the same required dissections as a part of the GCBA 571 curriculum, but did not complete the eight additional dissections and demonstrations required of the MMA16 students. The PA16 and PT16 classes attended the same Gross Anatomy Lab and Gross Anatomy Lecture as the MMA students, but participated in different courses outside of gross anatomy. The PA16 students were simultaneously enrolled in Physiology, Biology of

Disease, and Physician Assistant Professional Issues. The PT16 students were simultaneously enrolled in Physiology and Foundations of Physical Therapy Practice.



	MMA 2016	MMA 2015	PA 2016	PT 2016
Unit 1	75.07	75.2	85.02	80.6
Unit 2	76.58	77.44	83.02	81.16
Unit 3	76.03	77.44	83.94	81.07
Unit 4	86.49	77.39	89.81	88.26
Total	79.21	76.93	85.34	82.73

Figure 3.5: The average practical exam scores for MMA16, MMA 2015, PA16, and PT16 were compared. The average score for the course is also displayed for each class. The PA16 students, on average, scored higher on all unit exams and total course grade compared with the other students. Unit 4 exam average grades are significantly higher for all class cohorts except for the MMA 2015. The MMA 2015 class compared with MMA16 class had similar scores, about 1 grade point higher on unit two and three, but lower on unit 4. The MMA 2015 also had less variance between the grades than did the MMA16 students.

As seen in the above figure, PA16 students have higher unit exam scores as well as a higher total exam score when compared with all other students. Additionally, the scores for the Unit 4 exam are notably higher for the MMA16, PA16, and PT16 compared with their other unit exams. However, MMA15 does not have a higher score for Unit 4. MMA15 scores are less variable than the students in the 2016 GCBA 909 course. Of note, during the 2015 MMA program year, one student left the program after the completion of the Gross Anatomy course; however, the data from this student did vary significantly compared with the other 14 MMA15 students. During the statistical analysis, this student from the MMA15 class was eliminated to see if the statistical data was altered. However, both with and without this one student, the statistical data remained the same. This evaluation was to analyze whether the student influenced the data, but was not used to calculate the final results. All data in this study contains every student as a part of MMA15, MMA16, PA16, and PT16.

Analysis of Variance (ANOVA) was performed on the data comparing all class cohorts. The data was calculated to have statistical significance with a $p<0.01$. The p-value for the single factor ANOVA when comparing MMA15, MMA16, PA16, and PT16 was 8.52E-18 (Appendix F). After ANOVA, Tukey's post hoc test was performed on each relationship. Each relationship is shown in table 3.3.

Tukey's Post hoc Test Results			
Treatment Pairs	Tukey HSD Q statistic	Tukey HSD p-value	Tukey HSD inference
MMA16 vs MMA15	7.7662	0.0010053	** p<0.01
MMA16 vs PA16	4.7454	0.005521	** p<0.01
MMA16 vs PT16	2.9579	0.160816	insignificant
MMA15 vs PA16	14.5353	0.0010053	** p<0.01
MMA15 vs PT16	12.8134	0.0010053	** p<0.01
PA16 vs PT16	2.8655	0.1830901	insignificant

Table 3.3: Analysis of relationships between the samples using Tukey's post hoc test. Four relationships (MMA16 vs MMA15, MMA16 vs PA16, MMA15 vs PA16, and MMA15 vs PT16) were calculated to be statistically significant.

The relationship between MMA16 vs PA16, PA16 vs MMA15, PT16 vs MMA15, and MMA15 vs MMA16 were statistically significant with p values less than 0.01 using Tukey's post hoc test. The relationship between PA16 vs PT16 and PT16 vs MMA16 was found to be insignificant.

Student Surveys and Focus Groups:

Qualitative data was collected to measure students' outlook on the required additional dissections and demonstrations. Students were invited to complete a survey at the time of each of the two focus groups. Additionally, students were invited to complete a survey addendum in order to collect further information about students' anatomy education background.

The addendum helped to understand whether students had taken anatomy before attending the University of Nebraska Medical Center Master of Medical Anatomy program. As mentioned previously, there were originally 16 MMA students in the program, but one dropped from the program prior to exam 2 being administered. Therefore, only 15 MMA students from 2016 were analyzed. Of the 15 students, 12 had taken an anatomy course before enrolling at UNMC while 3 had never taken anatomy before.

Interestingly, while the students were enrolled in the course, there were several complaints to both the teaching assistants and professors. Students often found the requirement of additional dissections and demonstrations to be excessive and did not seem to like it as a part of the curriculum. The survey that was administered for this study was completed after the students had completed the course and received a grade.

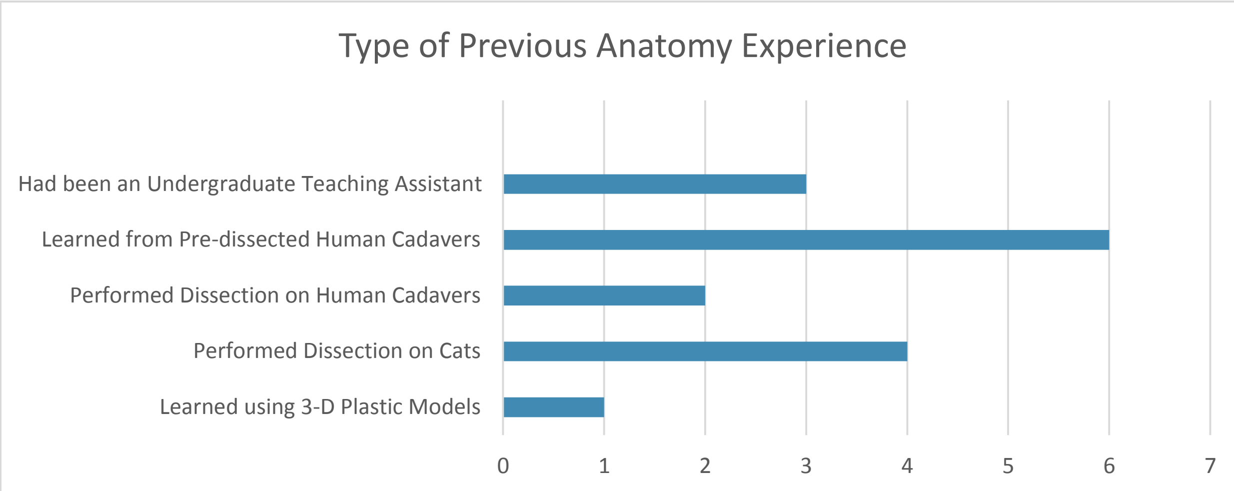


Figure 3.6: This figure displays the number of MMA students who had this type of self-reported anatomy background. 3 MMA students had previously been undergraduate teaching assistants. 6 MMA students learned anatomy using pre-dissected human cadavers. 3 MMA students performed dissection on human cadavers. 4 MMA students performed dissection on cats. 1 student did not perform dissection and reported to have learned anatomy using 3-D plastic models. Of note, one student reported to have dissected both a human cadaver and a cat.

Though 12 MMA students had taken anatomy prior to this UNMC MMA program, the students took part in different curriculum, thus had varied backgrounds in anatomy. Six of the twelve students who had taken anatomy prior to attending the MMA program at UNMC reported to have been taught using pre-dissected human cadavers. Three MMA students had been teaching assistants to undergraduate students and dissected the human cadavers while working with the students. Additionally, two students reported to have taken anatomy at an undergraduate institution which utilized human cadaveric dissection by students. Four students performed dissection on a cat (one student reported to have both performed dissection on a cat and a human cadaver). Lastly, one student who took anatomy during their undergraduate education reported to have learned using plastic anatomical models and neither performed dissection nor learned by observing a pre-dissected cadaver.

The surveys, which were given out prior to the focus group, utilized a Likert-type scale ranging from 1 (strongly disagree) to 5 (strongly agree). The students were asked to independently and anonymously rate each statement as it best fits their opinion. After completion of the surveys, the results were compiled (figure 3.6). The survey can be broken down into four different sections of related questions including the benefit, grades, learning experience, and time associated with the additional dissections and demonstrations. Notably, 73.33% of students felt the dissections were beneficial and 66.67% of the MMA students felt the demonstrations were beneficial. All 15 students disagreed to some extent (14 strongly disagree and 1 disagree) that the dissections and demonstrations negatively impacted their grades. However, only 12 strongly agreed and 3 agreed that their grades were positively impacted. Though the majority of students felt that the dissections and demonstrations were useful, there was a mixture of opinions about whether the course would be lacking educational tools if not for the dissections and demonstrations. There were 7 students who felt neutral about whether the course would be lacking tools if it were not for graded dissections and 6 who felt neutral about whether the course would be lacking tools if it were not for the demonstrations. The two statements related to time spent on the additional dissections and demonstrations showed similar results including ten of the fifteen students agreeing that the amount of time for the dissections did not affect their outside study time. Similarly, ten of fifteen students disagreed and one strongly disagreed that the time preparing for both the dissections and demonstrations was excessive.

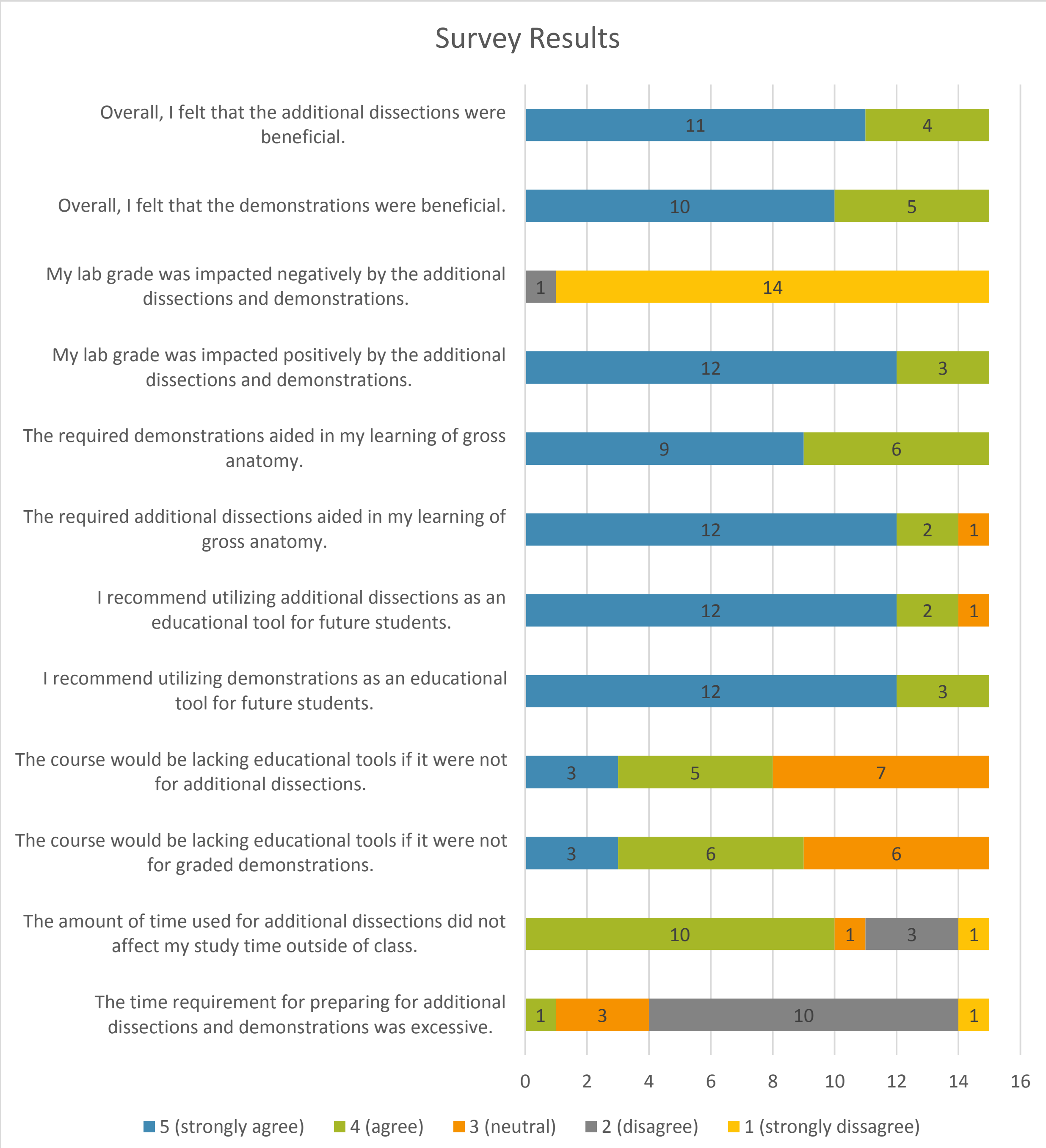


Figure 3.7: These survey results were completed by all 15 MMA students evaluated. Notably, most students self-reported that they felt that the additional dissections and demonstrations were beneficial with an average score of 4.73 (dissections) and 4.67 (demonstrations).

In addition to obtaining qualitative data by administering surveys, two one-hour focus groups were conducted. All 15 students came to either one of the two focus groups. The first focus group had 6 participants and the second focus group, held one day later, had 9 participants. These focus groups were recorded and transcribed. The focus groups were analyzed by searching for common themes discussed by the students in each focus group. There were four very commonly discussed themes within both focus groups including: hands-on experience, interprofessional collaboration, inclusion and exclusion of specific dissections and demonstrations, and future use of these educational tools.

Themes	Direct Student Quotes
Hands-on Experience	"…performing the dissections and actually seeing the structures while you dissect helps you learn it better." "We had extra time to see everything and use the entire body for our learning." "I learn best with hands-on activities, not just looking at the bodies." "The dissections were a lot more useful than looking at the prosections because we actually performed the dissections."
Interprofessional Collaboration	"…being able to teach a concept effectively such as the demonstrations aids in your own learning and allowed us to help the PA/PT students" "Many of us, at least I would, teach students who weren't MMAs because those students learned from the prosections. I got to practice my demonstration and help the other students."

	"I think we performed better dissection than PA/PT because we received grades, but this meant we could help them with hard topics too."
Inclusion/Exclusion of Specific Dissections and Demonstrations	"It was hard to do the pterygopalatine fossa because we did not do infratemporal fossa which is directly related to it. You had a harder time doing just the pterygopalatine fossa and ruined structures." "Giving the demo for the perineum was fine, but doing the dissection for it was not helpful." "I liked the larynx dissection. Larynx was good." "…inguinal canal was a good dissection because you actually had to understand the relationships between three different layers which made the practical easier." "I liked the vertebral canal dissection best because it was the first one and helped me learn how to look for all the terms." "We should add infratemporal fossa."
Future use of Additional Dissections and Demonstrations	"Yes, future students would learn more with these dissections and demos. For me, I felt that it gave me a better understanding, so I bet it would benefit other students too."

	"They should keep the additional dissections and demonstrations in the master's curriculum, but not with perineum dissection."

Table 3.4: There were common themes in both focus groups with quotes that support those ideas. These direct quotes from the students were from both focus groups.

In addition to the common themes found when analyzing the focus group results, there were a few statements made during the groups that most students did not acknowledge agreement to. One student stated, "Five minutes for each demonstration was more than enough except for perineum," while another student said, "I felt like I was an auctioneer trying to talk as fast as I could in five minutes." These two students mentioned the time that they were allowed during the demonstrations and most students did not say anything in regards to the time. Additionally, one student mentioned that, "The grading requirements were not straight forward enough." No other student stated anything else about grading. Overall, students found the dissections and demonstrations to promote hands-on learning and interprofessional collaboration. Most students agreed that the dissections and demonstrations should be continued for future MMA students. Though most students thought the dissections and demonstrations were useful, the majority of students did not recommend the perineum dissection for future students, but did feel that the perineum demonstration was useful. They explained that the perineum dissection was not the specimen they used to demonstrate because they did not have to disarticulate the pelvis. The students used a prosected specimen during their demonstrations instead. Three times throughout the first focus group, students mentioned that the most useful dissection was the pterygopalatine fossa due to its complexity.

When asked if students would recommend UNMC continue to require MMA students to perform additional dissections and demonstrations, the majority of students agreed that it should remain a part of the curriculum. Most students believed it helped them perform better on the practical examinations as well as their lecture tests, but students did not think it helped with the living anatomy component. Living anatomy is a part of the curriculum that requires students to demonstrate anatomical landmarks and basic clinical tests during the practical. Most students had a positive outlook on the inclusion of the additional dissections and demonstrations and did believe that it positively impacted their grades.

Chapter 4: Discussion

Student Performance

The MMA16 students' performance on each unit exam shown in Figure 3.1 shows the relationship between the number of incorrect associated questions and the number of correct questions on the unit practical examinations. The data is not normally distributed, most likely due to the small sample size, so the data was tested using Kruskal-Wallis test which showed no statistical significance. Using a scatter plot, a trendline was evaluated using R^2 values. The unit three exam had an R^2 value of 0.0391 whereas Unit 4 had an R^2 value of 0.7377. The difference between these two is large. An explanation for such a large difference could be that the MMA students only participated in one required additional dissection and demonstration in Unit 3 while they had three required additional dissections and demonstrations in Unit 4. This difference could have attributed to both the relationship between each students' grades on Unit 4, but also the increase in the scores on the Unit 4 exam (almost 10% higher on the Unit 4 exam).

The percentage of correct questions associated with the additional dissections and demonstrations was compared with the students' percentage of correct questions not associated with the additional dissections and demonstrations. The results were expected to show student performance to be higher on the associated questions or similar between the two factors. The results showed that the majority of students performed better, on average, on the associated questions than the unassociated questions on Unit 1, Unit 3, and Unit 4 exams. However, students performed better, on average, on the unassociated questions during the Unit 2 exam.

PT16 students, on average, scored higher on the unassociated questions on Units 1 and 2, but scored about the same on Units 3 and 4. PA16 students, on average, scored similar on all unit examinations. PT16, PA16, and MMA16 performance on associated and unassociated questions was compared to evaluate whether the MMA16 students were at advantage by performing the dissections. The scores were not much higher, but there was a more significant correlation between MMA16 associated versus unassociated performance compared with PA16 and PT16 students.

The average unit practical exam scores and total course scores were compared between the MMA16 class and the MMA15, PA16, and PT16 classes. The p-value (8.52E-18) was calculated to analyze the relationship between these four class cohorts and it was found to be statistically significant with a confidence interval of 95%. This data was then analyzed using Tukey's post hoc test to establish which relationships were significant. The Tukey's post hoc test showed that of the six relationships, four of them were statistically significant with a 99% confidence interval as shown in Table 3.3. In addition to performing ANOVA and Tukey's test, t-tests were run to evaluate the relationship between each of the three classes and the MMA16 class. T-test confirmed that we were unable to reject the null hypothesis. Therefore, the quantitative data shows that there is not a statistically significant correlation between students' assessment performance on each unit practical examination and total course score when compared with MMA15, PA16, and PT16. One explanation for this result is that the students of the MMA16 compared with PA16 and PT16 have different career goals in mind. The MMA16 students are in this program before attending professional school, so they are likely working on outside responsibilities such as professional school applications, admission tests, and shadowing experience. The students of the PA16 and PT 16 classes are currently enrolled in their professional school program and most likely have the goal of their career, possibly without the outside distractions that the MMA15 students face. Also, the sample sizes of the two MMA class cohorts were small, thus limiting the data. Compared with the number of students in the PA and PT classes, the MMA sample sizes were much smaller.

The MMA15 class compared with MMA16 had less variance in their unit exam scores, despite having the same sample size. The MMA15 students had the same curriculum, but did not have the same required additional dissections and demonstrations that the MMA16 students had. The MMA15 students were also not graded on the three additional dissections that they performed and did not demonstrate them to GCBA professors. The students also had different professors each year, so the exams were written by different faculty. The relationship between MMA15 and MMA16 does not show any statistical significance, but is notable to have a significantly different score on Unit 4. This is likely due to the difference between the two MMA years, but could also be contributed to the three dissections and demonstrations that MMA16 students performed in Unit 4.

The study done by Nwachukwu et al. (2014) showed a significant correlation between the quality of the dissection (grade) compared with the practical exam scores. However, it also showed a negative correlation between the ARS quiz scores and the quality of dissection. This negative correlation is likely because students spent more time working on the dissection than studying for the quizzes. In our study, we did not assess the lecture scores, but anecdotally from discussions with the students during and outside of gross anatomy lab, as well as during the focus group, students have mentioned that the additional dissections subjectively helped their lecture grades.

Student Perceptions

In addition to quantitative data, this study analyzed qualitative data by way of surveys and focus groups. The results of the qualitative data show an overall positive outlook regarding the additional dissections and demonstrations. On the survey, the students "strongly agreed" or "agreed" that additional dissections and demonstrations were beneficial overall. The students supported this opinion in the focus groups by explaining that the additional dissections helped them with hands-on learning of anatomy and the demonstrations allowed them to teach the information so they understood it on a deeper level. These positive qualitative results were expected because students had expressed their positive outlook on their anatomy skills throughout the course, especially after completing some of the additional dissections and demonstrations.

The survey also showed that the majority of students would recommend that additional dissections and demonstrations be required in the MMA curriculum in the future. The students seemed to feel that the additional dissections and demonstrations helped them with their performance and understanding in the course even though the grades did not reflect this feeling.

The conflicting results between the quantitative and qualitative results may be due to the fact that the impact may not have been reflected in their grades, but rather the confidence of the students. Students suggested in the focus groups that they knew the information better than they would have without the additional dissections and demonstrations. Despite the difficulty and time-consuming nature of the additional dissections and demonstrations, students still believed it to be beneficial overall and the majority of students recommended it be used in the future. The confidence in their anatomical skills could have been enhanced from these tools. One student said in the focus group, "I know for me, the demos gave me more confidence. I actually know what I am looking at when it's time to study for the exam." Though the additional dissections and demonstrations may not have increased the students' grades, it did give them more confidence in their knowledge. Per the students' feedback, the curriculum provided hands-on learning opportunities and enhanced interprofessional collaboration. The enhancement of hands-on learning, as shown in past studies such as the two discussed in the introduction by Paris et al. and Kontra et al., enhances learning in the classroom. This study found that the students do value the hands-on learning provided by the additional dissections. This suggests that the curriculum is beneficial to the students' academic performance.

Research Limitations

A major limitation of this study is the sample size. There were only 15 MMA students this year and 15 MMA students in the year prior. This sample size is not able to be expanded at UNMC due to the limitation in size of the program. One way we could address this limitation is to perform a similar study with program that has a larger student class. In addition to the small sample size, there were only 6 available unit 1 exams which limits the significance of that data. The sample size for PA and PT students was much larger than the MMA16 class with 58 PA students and 62 PT students with also limits the statistical significance.

The MMA16 class was compared to the MMA15 class who took the course one year prior to the MMA students who participated in the graded additional dissections and demonstrations. The professors who taught during 2015 were different than those in 2016. Therefore, the unit exams were written and graded by different faculty each year, but were similar in style. The MMA15 class had a living anatomy component that was factored into their practical exam and total course grade. The living anatomy component to the course was also taken by the MMA16 students, but was not factored into their GCBA 909 exam or course grades.

We plan to analyze future MMA classes who do not have the living anatomy component as a part of their grade, so that this limitation is eliminated.

In regards to the survey, students were not asked about their anatomy background in the original survey, so we are unable to compare the results of students who had anatomy experience to those who did not. This would have helped to evaluate the correlation between their opinion of the additional dissections and demonstrations to their previous anatomy experience. In the future, this should be asked in the initial survey.

Finally, this study evaluates students' performance on practical examinations and additional dissections and demonstrations, but there is a limitation on determining what outside factors may have contributed to the results. This could be addressed by conducting this study with a larger sample size and over a longer period with different class cohorts. Also, in the future we plan to conduct surveys throughout the course after each exam to assess their perspective on each unit, instead of just the entire course as we did in this study.

I will continue to study future MMA classes to see the trends throughout later years. Also, surveys will be conducted throughout the course and will obtain information about previous anatomy education within the initial surveys. The focus groups were helpful to analyze the personal feedback from each student, so one-on-one interviews will be added so that each students' opinions are better understood. In the focus groups and one-on-one interviews, I will ask students to explain why they have the opinion about the curriculum, so that I can closely study the specific benefit of the additional dissections and demonstrations despite the lack of statistically significant quantitative data.

Conclusion

Overall, this study showed positive qualitative data to support grading dissections and demonstrations, but did lack statistical evidence that assessment grades are directly affected using graded dissections and demonstrations. Though the grades of the master's students may not have reflected a significant increase, the self-confidence and positive opinions of the students suggest there is benefit to including dissection grades into the gross anatomy lab curriculum. The hands-on nature of dissection as well as the impact on interprofessional collaboration that this curriculum was viewed in a positive way by the students. The required additional dissections and demonstrations were subjectively difficult and time-consuming, but were still considered beneficial by the master's students. Despite the lack of significant correlation between the unit practical exam grades and graded dissections and demonstrations, this education tool may be beneficial for student outcomes in gross anatomy lab; especially at UNMC. The dissections were found to be beneficial to hands-on learning from students. Though the positive contribution from the graded dissections and demonstrations may have only had a placebo effect, the students did report a benefit in gross anatomy lab. The MMA program would benefit by continuing to require students to participate in these graded dissections and demonstrations as well as continuing this study to see if longevity contributes to the statistical findings.

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Appendix A: Student Consent Form

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NARRATIVE CONSENT

Title of this Research Study

Analysis of Graded Gross Anatomy Dissections and Demonstrations as a Supplemental Educational Tool

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

You are being asked to participate in this study because you are a master of medical anatomy student who enrolled in the Gross Anatomy Lab in fall 2016. You took part in graded dissections and demonstrations while in the Gross Anatomy Lab.

This research is designed to (1) better understand the impact the dissections and demonstrations had on grades and (2) determine whether this educational tool will benefit future students.

If you agree to take part in the study, you will participate in survey and focus group on January 31, 2017 or February 1, 2017. After the study, data from the focus group and survey as well as course and exam grades will be analyzed.

There are no known risks or costs to you from being in this research study, and you are not expected to receive benefits from being in this research study. The results of this study may benefit future students who enroll in the master of medical anatomy program at UNMC by providing research to help inform future course designs. Reasonable steps will be taken to protect your privacy and the confidentiality of your study data.

The only persons who will have access to your research records are the study personnel, the Institutional Review Board (IRB), and any other person or agency required by law. The information from this study may be published in scientific journals or presented at scientific meetings but your identity will be kept strictly confidential.You can decide not to be in this research study, or you can stop being in this research study (withdraw) at any time before, during, or after the research begins.

Deciding not to be in this research study or deciding to withdraw will not affect your relationship with the investigator, or with the University of Nebraska Medical Center. You are freely making a decision whether to be in this research study.

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Medical Center

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Signing this form means that (1) you have read and understood this consent form, (2) you have had the consent form explained to you, (3) you have had your questions answered and (4) you have decided to be in the research study. If you have any questions during the study, you should talk to one of the investigators listed below. You will be given a copy of this consent form to keep.

Signature of Subject: ____
Date: _____________

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

Signature of Person Obtaining Consent: _______________________________
Date: _____________

Authorized Study Personnel
Principal Investigator (PI): Cassidy, Keely M, Ph.D. ; 402-559-8288
Secondary Investigator (SI): Gould, Karen A, Ph.D.; 402-559-2456
Participating Personnel: Cummings, Stephanie L

IRB Approved
Valid until 12/22/2021

Appendix B: Grading Rubric

	Deficiency	Needs Improvement	Mastery
Completeness and clarity of dissection **4 pt**	Many (deficient in more than 3) structures located, complete, delineated, and clear to the extent of the current dissection. 0-2 pts	Most (may be deficient in 3) appropriate structures located, complete, delineated, and clear to the extent of the current dissection. 3 pts	All appropriate structures located, complete, delineated, and clear to the extent of the current dissection. 4 pts
Anatomical knowledge in verbal presentation **4 pt**	• Information presented verbally in ~5 min or used assistance of notes. and/or • Many (deficient in more than 3) appropriate structures identified, described, and given context and relationships to other structures to the extent of the current dissection. and/or • Many anatomical variants and/or pathologies present are not noted. 0-2 pts	• Information presented verbally in greater than 1 min variant of 5 min (<4 or >6 min). and/or • Most (may be deficient in 3) appropriate structures identified, described, and given context and relationships to other structures to the extent of the current dissection. and/or • Most anatomical variants and/or pathologies present are noted. 3 pts	• Information presented verbally in 5 min (variant within 1 min acceptable; 4-6 min). • All appropriate structures identified, described, and given context and relationships to other structures to the extent of the current dissection. • All anatomical variants and/or pathologies present are noted. 4 pts
Cleanliness of dissection and viewing field **1 pt**	Area of dissection and table are not clean and free from unnecessary dissection implements, tissues, and fluids. 0 pt	Area of dissection and table are almost clean and free from unnecessary dissection implements, tissues, and fluids. 0.5 pt	Area of dissection and table are clean and free from unnecessary dissection implements, tissues, and fluids. 1 pt
Professionalism **1 pt**	Not presented with professionalism and/or confidence. 0 pt	Presented with slight deficiency in professionalism and/or confidence. 0.5 pt	Presented with professionalism and confidence. 1 pt
Faculty Comments (if any): **Final Grade = /10**			

Appendix C: Survey

Gross Anatomy Additional Dissection and Demonstration Survey

For each statement below, circle the number that best describes your opinion.

Overall, I felt that the additional dissections were beneficial.

1 (Strongly Disagree) 2 3 4 5 (Strongly Agree)

Overall, I felt that the demonstrations were beneficial.

1 (Strongly Disagree) 2 3 4 5 (Strongly Agree)

My lab grade was impacted negatively by the additional dissections and demonstrations.

1 (Strongly Disagree) 2 3 4 5 (Strongly Agree)

My lab grade was impacted positively by the additional dissections and demonstrations.

1 (Strongly Disagree) 2 3 4 5 (Strongly Agree)

The required demonstrations aided in my learning of gross anatomy.

1 (Strongly Disagree) 2 3 4 5 (Strongly Agree)

The required additional dissections aided in my learning of gross anatomy.

1 (Strongly Disagree) 2 3 4 5 (Strongly Agree)

I recommend utilizing additional dissections as an educational tool for future students.

1 (Strongly Disagree) 2 3 4 5 (Strongly Agree)

I recommend utilizing demonstrations as an educational tool for future students.

1 (Strongly Disagree) 2 3 4 5 (Strongly Agree)

The course would be lacking educational tools if it were not for additional dissections.

1 (Strongly Disagree) 2 3 4 5 (Strongly Agree)

The course would be lacking educational tools if it were not for graded demonstrations.

1 (Strongly Disagree) 2 3 4 5 (Strongly Agree)

The amount of time used for additional dissections did not affect my study time outside of class.

1 (Strongly Disagree) 2 3 4 5 (Strongly Agree)

The time requirement for preparing for additional dissections and demonstrations was excessive.

1 (Strongly Disagree) 2 3 4 5 (Strongly Agree)

Additional Comments/Suggestions:

Appendix D: Focus Group Questions

1. Explain what the objective of additional dissections and demonstrations was?

2. Were there benefits to having additional dissections? Demonstrations? Examples?

3. Were there drawbacks to having additional dissections? Demonstrations? Examples?

4. How did the additional dissections/demonstrations affect your experience in gross anatomy?

5. Would you recommend using additional dissections and demonstrations as an educational tool for future students?

6. Did you feel that the time requirement for preparing for additional dissection and demonstration was adequate? Excessive? Specific Dissections? Demonstrations?

7. Was there one or more particular dissections that you felt did or did not meet the goals of the curriculum?

8. Is there one or more dissections you would exclude for future students?

9. Was there one dissection that was more beneficial than all the rest?

10. Do you have any further comments about the additional dissections/demonstrations you would like to add at this time?

Appendix E: Survey Addendum

Had you taken anatomy before Fall 2016?

YES NO

If you answered YES:

Did your anatomy include either dissection or prosection of a human cadaver?

YES NO

If yes, did you perform dissection or were you taught using a pre-dissected cadaver?

If no, what type of dissection was used? (i.e. dissection of cat, shark, or other animal)

If your anatomy course did not include dissection, please briefly explain the course below:

Appendix F: ANOVA

Anova: Single Factor

SUMMARY

Groups	Count	Sum	Average	Variance
MMA16	15	3167	211.1333	376.7667
MMA15	15	2596.5	173.1	389.3643
PA16	58	13315	229.569	315.5478
PT16	62	13798	222.5484	390.3501

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	39785.16	3	13261.72	36.86377	8.52E-18	3.918609
Within Groups	52523.41	146	359.7494			
Total	92308.57	149				