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The Effectiveness of Drawing as a Study Tool for Success in Human Anatomy and Physiology

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THE EFFECTIVENESS OF DRAWING AS A STUDY TOOL FOR SUCCESS IN HUMAN ANATOMY AND PHYSIOLOGY

By
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A thesis submitted to the faculty of The University of Mississippi in partial fulfillment of the requirements of the Sally McDonnell Barksdale Honors College.

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ABSTRACT

Human Anatomy and Physiology courses are packed with substantial information to obtain and retain over a semester. Study techniques students integrate into their studies are indispensable in affecting their success or failure in Human Anatomy and Physiology courses. This study aimed to determine if using drawing as a study technique would positively or negatively impact students' success or failure rate in Human Anatomy and Physiology I (A&P I) at the University of Mississippi. Participants were divided into three groups based on the degree of participation. Group A students chose only to release their unidentified test scores. Group B students released their unidentified test scores and participated in three surveys. Group C students released their unidentified test scores, participated in three surveys, and attended three drawing sessions. Relevant survey questions were categorized as positive, negative, or drawing and were analyzed for correlations to each other and course performance. Each was analyzed for correlation to student performance on significant assessments in the course. Significant correlations were found amongst relevant survey question frequencies and major assessments for students enrolled in Bisc 206 at the University of Mississippi in fall 2022. The findings suggest that students had a false sense of knowledge which was caused by students' lack of active studying tools and engagement with the material. The false sense of knowledge is seen in the significant negative correlation between Survey 1 draw association questions and exam scores. The findings are useful for further studies incorporating active studying and engagement into students' study routines.

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INTRODUCTION

Anatomy without cadavers does not exist meaningfully; the same can be said for the teaching of Anatomy without "full exploitation of the strength of an image" (Mavrodi et al., 2013). Without the visual representation of an image, students who have never attended a dissection would be unable to understand the inner morphology of the human body (Mavrodi et al., 2013). From the beginning, drawing and Anatomy have remained interlaced with the first anatomical illustration completed by Giacomo Berengario da Carpi, famously known for his depiction of a muscleman (Mavrodi et al., 2013). Although anatomists and artists share few vocabulary words, they share three significant aspects in learning anatomy: observation, investment, and perspective. For anatomists or students of anatomy, "the ability to draw is an irreplaceable qualification because when one attempts to depict the relations among the anatomical elements, it forces a deep understanding of science"; consequently, the anatomists find important aspects "that should be clarified and explained in detail when taught or be kept in mind in clinical practice" (Mavrodi et al., 2013).

Surgeons commonly describe drawings "to serve aid memories, helpful in the recollection of the pathology and procedures are done, post-operative care, follow-up up care planning further operative intervention" (Kearns, 2019). With the knowledge of practicing surgeons incorporating drawing into their practice, "it is important for basic science knowledge to be transferred into clinical skills in education; a clear example of this continuum is knowledge of anatomy" (Alhamdani & Hatem, 2017). Therefore, incorporating drawing as a means of learning Human A&P I could be used outside of the undergraduate course, transferring as an aid in the clinical practice of all health professions. Likewise, most undergraduate students enrolling in Human A&P I are likely

pursuing a career path in the medical world in which the "importance of good anatomical knowledge of the human body is fundamental in clinical practice and underpins the safety in the field of surgery" (Borrelli et al., 2018).

Drawing to learn anatomy encourages student participation, often different from the typical teaching method in Human A&P I. Typical teaching of Human Anatomy and Physiology "emphasizes rote memorization and minimizes student participation" (Lunsford & Diviney, 2020). On the other hand, learning anatomy through drawing is "more engaging, and it encourages students to visualize and better understand anatomical planes, allowing them to retain anatomical knowledge easier." An experiment was designed to "access the efficacy of drawing as a tool for teaching." It included four drawing workshops, each three hours long and focused on the upper limb, lower limb, thorax, and head and neck regions. Results from their study showed a "statistically significant mean improvement of 1.11 points across all workshops ($p = 0.0007$) with a confidence interval (CI) (0.52-1.71)" and a statistically significant mean improvement of participants pre (1.59) and post (2.63) quizzes with ($p=0.0001$) with a confidence interval of 0.63-1.44. Some students reported that "the workshops aided them to recap previous knowledge and better visualize anatomical compartments and planes" (Borrelli et al., 2018). Students also said that course improvements could be made by integrating drawing sessions into the curriculum, more drawing time, and more sessions covering other anatomical regions.

From the study, data showed that "31 out of 32 students completed the self-rated knowledge of anatomy and showed a significant post workshop improvement of 1.77 points (41.4%)" (Borrelli et al., 2018) and an overall satisfaction rate of 91% for the course. Researchers identified that students acquired the "ability to identify key anatomical features and ability to simplify bones and muscle attachments in their drawings" (Borrelli et al., 2018). Though students heavily rely on the dissection of

cadavers in aiding their gain of knowledge in anatomy, the curriculum has swayed from this practice; instead, using drawing as a "method to teach or learn anatomy may aid student's conceptualization of the 3-D nature of anatomy in a similar way that dissection can offer" (Borrelli et al., 2018).

Previous research on drawing as a means to study Human Anatomy and Physiology proved beneficial for university students, showing higher test scores, focus, and long-term retention of information. Yet, students and instructors alike are reluctant to use drawing due to self-perceptions of an inability to draw. This project aims to identify (1) prior use of drawing as a study tool, (2) willingness to learn drawing as a study tool, (3) willingness to attend a drawing instruction session (no live human figures used), (4) use of drawing over the semester, and (5) relationship to performance in students enrolled in Human Anatomy and Physiology at the University of Mississippi. A series of surveys will be used in conjunction with drawing instructions to assess the value of the technique and the possibility of broader use of the method in future course offerings. Further research into the topic of drawing within anatomy classes is highly relevant and important because most students who take Human A&P I typically want to enter the medical or nursing field, both heavily influenced by the study of anatomy. This study aimed to increase the retention of information, test scores, and learnability of Human A&P I. Therefore, the interest and desire to research the effectiveness of drawing as a study tool in Human A&P1 became pertinent.

MATERIALS AND METHODS

Students (n = 268) enrolled in Human A&P I during the Fall 2022 semester at the University of Mississippi were recruited to participate in this study. Of the 268 students recruited, the ratio of male to female students was 55:213, with an average age of 20.01 $\pm$ 1.69. All lecture and laboratory sessions in the Fall of 2022 were held in person. This protocol was determined as exempt under 45 CFR 46.101(b) (#2) by the University of Mississippi Institutional Review Board (Protocol #22x-286).

Students were placed into Groups A, B, or C based on student choice. Group A students consented to their scores being used for statistical analysis. Group B students completed all surveys but did not participate in drawing sessions. Group C students participated in drawing sessions and completed Survey 1 and an exit survey.

Survey 1 questions aimed at obtaining basic background information on study tools students used in previous courses and what they planned to use during their semester of Anatomy and Physiology 1. We used a scale with options ranging from strongly agree (SA) to not applicable (N/A). Obtaining a baseline of study strategies would allow us to analyze if a correlation existed between study techniques and test scores. Survey 2 questions aimed to understand how students' study techniques changed or did not and how they correlate to students' attitudes towards Human A&P I. Survey 3 questions intended to gain insight into how study techniques, specifically drawing techniques, used over the semester related to students' learnability and satisfaction with Human A&P and whether those strategies would remain valid.
Each drawing session covered material already covered in class, but students participated in the drawing sessions before the exam that would have the session's material. Although participants completed each session online, students chose an asynchronous online and in-person drawing session. We wanted students to have both

options to determine which form of the session they felt most comfortable participating in and what worked best for their schedule.

Active Presenter Pro, a downloadable software from activepresenter.com, allowed me to create each session. Active Presenter Pro allowed us to screen record, input audio for each session, and use animation for each drawing session. After the drawings were made for each slide and the "animation" (the appearance of when each line/structure would appear) was completed, we created audio for each slide. We outlined what we would say for the audio, recorded each section, and edited the audio to fit the slides. The software Active Presenter created drawings for participants to follow along with. Examples of these drawings can be seen in Figure 1.

Students participating in the drawing sessions had a week and two days to complete the drawings and turn them in. We wanted to set a deadline for the drawings since most students are encouraged to complete an assignment if there is a deadline. We also wanted students to complete the drawing sessions before they were tested on the information presented in the drawing session. We used a scale ranging from 0 to 3 to score each submitted drawing. A score of 0 meant students did not follow the drawing session video or had no drawing completed. A score of 1 represented student followed along with the drawing session video, yet the submitted drawing showed no effort by the student. A score of 2 meant students followed along with the video and put forth an effort, yet the student did not include one of the outlined structures presented to them. A score of 3 meant the students submitted drawings that included all drawings, the accuracy of anatomical structures, and effort in their drawings. Group C exit survey obtained students' attitudes towards the drawing sessions. Students' attitudes to participating in the drawing sessions play a significant role in how students benefit from each session.

At the end of the semester, survey responses were compiled with student performance scores (e.g., Exam 1, Exam 2, Exam 3, Exam 4, percentage grade date to each respective exam, midterm grade, and final grade) and de-identified before analysis. Where relevant, survey questions were categorized as positive statements about the course, negative statements about the course, or drawing-related statements about the course. Summed category scores for each student were then analyzed via Pearson correlation tests for each pairwise comparison of category scores, exam scores, lab practical scores, and course averages. The level of significance was set at alpha = 0.05. Frequency data and descriptive statistics were calculated for all survey questions. All statistical tests were conducted using SPSSV27 software licensed to the University of Mississippi.

RESULTS

Most participants are majoring in allied health studies, pursuing a career in the nursing field, and are in their second year of undergraduate studies, as shown in Figures 2 – 4. Table 1 shows participants' answers, categorization, and mean score +/- standard deviation for Survey 1. Table 2 shows participants' responses, categorization, and mean score +/- standard deviation for Survey 2. Table 3 shows participants' answers, categorization, and mean score +/- standard deviation for Survey 3.

There was a significant negative correlation between Survey 1 Draw association questions, and Lab Practical 1 scores ($p = 0.030$), Exam 4 scores ($p = 0.016$), and Exam 5 scores ($p = 0.047$) (Figure 5). There was a significant positive correlation between Survey 1 draw association questions and Survey 1 negative ($p = 0.001$) and positive association questions ($p < 0.001$) (Figure 6). There was a significant positive correlation between Total_neg and Total_draw association questions ($p = 0.011$) (Figure 7). There was a significant negative correlation between Total_neg and Total_pos survey association questions ($p < 0.001$) (Figure 7). There was a significant positive correlation between Survey 3 negative association questions and Total_pos ($p < 0.001$) and Total_draw association questions ($p = 0.001$) (Figure 8). There was a significant positive correlation between Exam 2 scores and Total_pos association questions ($p = 0.046$) and Survey 3 positive association questions ($p = 0.017$) (Figure 9). A significant negative correlation existed between Exam 2 scores and Survey 1 negative association questions ($p = 0.036$) (Figure 9). There was a significant negative correlation between Total_neg association questions and PGTD_F ($p = 0.007$) (Figure 10). Examples of the scored drawings can be seen in Figure 11.

DISCUSSION

The objective of our study was to determine the effectiveness of incorporating drawing as a study technique to be used in Human A&P I at the University of Mississippi. With the course load that Anatomy and Physiology has at any university, we wanted to analyze if drawing leads to students engaging with the material, leading to a better understanding of Human A&P I.

Student participation in the drawing sessions began with 40 participants, but of the 40 participants, only 4 students completed all drawing sessions. This could be due to students feeling as if the drawings took too much time, were not helpful, were uncomfortable trying new studying methods, or dropped the class. Post-drawing session survey feedback showed that students who completed the drawing sessions felt optimistic about the sessions and their effectiveness as a study technique.

Visual representations have always been aspects of student learning, as early as learning to read, and up to college, learning the Anatomy and Physiology of the human body. Visual representations allow students, whether learning to read or learning human anatomy, to connect the meaning of words to what the visual representation is showing. Allan Pavio created the Dual Coding Theory, which is based on the idea that two types of stimuli, verbal stimuli (comes in as speech) and non-verbal stimuli (comes in through touch, sight, sound, or taste), can "form associations and are capable of cross-linking to form referential connections" (Gilbert, 2010). Pavio's dual coding theory suggests that "the activity in the brain (during the learning process) is visualization, and it operates on models" (Gilbert, 2010), explaining why "most stem-instructed courses use visual representations to illustrate important concepts" (Rau et al., 2017). An example is using "ball-and-stick models to visualize the spatial arrangement of molecules in determining if a relationship exists between structures." (Rau et al., 2017). In the same way, through

the use of visual representations, Anatomy students can fully understand a phenomenon by giving students a mental image connecting structure, function, and "the 3-D nature of anatomy" (Borrelli et al., 2018). Without visual models to assist, these courses would be increasingly challenging due to the "spatial and temporal dimensions of biology, involving complexity that challenges the limits of human comprehension." (Quillin & Thomas, 2015).

Our research found a significant relationship between negative and positive association questions in relation to drawing association questions and a significant negative correlation between Lab Practical 1, Exam 4, and Exam 5 scores concerning Survey 1 Draw association questions. Most students reported that their study strategies did not include active forms of learning such as drawing, flashcards, or Quizlet; instead, students' study strategies were mainly confined to reading over their notes which can lead to a false sense of knowledge, coinciding with student reports of not engaging with the material obtained from a lecture. The significant negative correlation between Survey 1 draw association questions and exam scores shows the lack of active studying and engagement with the material. The significant relationship between the negative and drawing association questions can be attributed to students' lack of active studying methods such as drawing. Our research also showed that most students would not continue to use study strategies used in Bisc 206 in future studies of anatomy and physiology or in future courses. Students who participated in the drawing sessions reported that drawing kept them more engaged while increasing comprehension and learnability of the material. They had a positive attitude towards the sessions and felt each session was important to complete.

In Human A&P I, understanding the material relies on a circular feedback loop, beginning with the absorption of the material and ending with engagement with the material. Material that is absorbed comes from an outside source, such as attending a

lecture; this absorbed material has no clear meaning or structure without engagement. Engagement of material forces students to mentally manipulate the absorbed material, which constructs or adds to knowledge. Physical or cognitive tasks can do this through drawing, quizzing, or summarizing. In many ways, drawing can be considered a mindless activity children partake in. However, if students actively engage in their drawings by "selecting, organizing, and integrating information, the practice of drawing to learn can benefit students in their knowledge, communication, and problem-solving with a topic (Heideman et al., 2017).

Along with actively engaging in material, drawing requires students to reason where certain lines, structures, or parts are placed in their drawings, leading students to "foster conceptual change and meaningful learning" (Quillin & Thomas, 2015). The act of drawing to learn Human A&P1 provides students with a method in which they can engage with the material absorbed. Drawing is a "learner-generated external visual representation depicting any type of content" (Quillin & Thomas, 2015). Accordingly, drawing as a method of learning Anatomy and Physiology "has been shown to increase learning and retention of material and to be effective in increasing learner engagement with material" (Greene, 2018).

Researchers experimented to determine the relationship between how drawing can boost memory. The experiment was called "The Drawing Effect"; in this study, researchers "systematically examined whether drawing pictures depicting to-be-remembered information boosted memory more than other encoding strategies did" (Fernandes et al., 2018). Participants in the study were instructed to follow along with a list of thirty words, each word followed by a prompt that required students to use one of the following encoding mechanisms: drawing, in which participants were asked to draw a picture to illustrate the word presented or writing in which participants were asked to write the word explained multiple times. The same experiment was tested in a lecture

hall where 10-30 students participated (Fernandes et al., 2018). Results from this experiment showed that "words drawn relative to written at encoding were better recalled" (Fernandes et al., 2018), and not surprisingly, the effect of drawing seen in the lecture hall established "drawing as an effective and reliable encoding strategy, far superior to writing" (Fernandes et al., 2018).

The argument made throughout this work has been that drawing as a means of studying Human A&P I is essential for students' engagement, comprehension, and success in Human A&P I due to previous research between the two. In particular, it was demonstrated that drawing, a form of active learning, could directly benefit students' engagement with the material absorbed during a lecture, retention of the material, future stem-related courses, and throughout their health-related careers. To benefit the students, they had to recognize drawing as an essential task to be completed while intentionally placing lines and structures in their correct anatomical positions. Since many institutions have strayed from using cadavers to teach anatomy and physiology (Mavrodi et al., 2013), it is crucial to find new methods accessible to students that give them a deeper understanding of the material; in this case, we explored the use of drawing as a means to provide students with that. The importance of drawing in anatomy and physiology is seen through continuous use by practicing physicians and courses students will later enroll in. Many students in Human A&P I want to pursue a career in the health field, meaning their knowledge of anatomy and physiology goes beyond classroom lectures and exams; the students will need to retain the information learned while being able to apply that information to real-life circumstances. Through drawing, students must engage with the material absorbed, thus leading to retention, understanding, and application of the material. Drawing is only one study tool that enhances a student's skills in Human A&P I. Future studies should explore other forms of active learning that require students to engage in absorbed material while still

including drawing; by doing so, teachers will gain a greater understanding of how the mass majority of students learn and allow students to have a positive attitude towards anatomy and physiology courses.

In particular to this study, many improvements can be implemented for future studies. Participation in drawing sessions was minimal, leading to easily repudiated results. Increasing participation size starts with changing students' perspectives on how productive their time will be spent during drawing sessions and how it correlates to an increase in their grades. The initial participation size would have produced more robust results; thus, in future studies, knowing how to hold participants' interest in the study will be necessary.

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Table 1. Frequency, mean, and standard deviation of Human A&P I student responses to survey 1. Student responses are recorded as (SA = strongly agree, A = agree, D = disagree, SD = strongly disagree, NA = not applicable). Categorization concerning course performance is listed for relevant survey questions (+ = positive, - = negative, d = draw)

Survey Question	SA (1)	A (2)	D (4)	SD (5)	NA (6)	Mean score ± SD	Category
As of now, do you feel confident in your study strategies?	27	5	164	21	7	3.93 ± 0.90	+
Do these strategies implement a variety of techniques such as drawing, writing, Quizlet, or flashcards?	87	6	116	12	3	4.23 ± 0.92	+
As a student, do you find yourself strictly memorizing the information on a particular test?	35	12	111	61	5	3.50 ± 1.25	d
For the Final Exam, will you have to re-learn the material from the beginning of the semester?	43	6	99	58	17	3.74 ± 1.31	-
If you were asked to identify specific anatomical structures (taught in the class) on a cadaver, would you be confident in correctly identifying the particular structures?	20	4	129	45	25	3.85 ± 1.22	-
Do you feel engaged when you study for upcoming exams?	34	5	148	31	5	3.85 ± 0.99	+
I use colors (highlighters, pens, markers) to aid me in studying	90	6	80	45	3	3.95 ± 1.23	+, d
Do you notice yourself daydreaming, zoning out, or wanting to get on your phone while studying for upcoming exams?	63	10	106	35	9	3.91 ± 1.21	-
I feel confident in my drawing abilities.	24	32	75	78	15	3.12 ± 1.51	d

Table 2. Frequency, mean, and standard deviation of Human A&P I student responses to survey 2. Student responses are recorded as (SA = strongly agree, A = agree, N = neutral, SD = strongly disagree, D = disagree, NA = not applicable). Categorization concerning course performance is listed for relevant survey questions (+ = positive, - = negative, d = draw).

Survey Question	SA (1)	A (2)	N (3)	SD (4)	D (5)	NA (6)	Mean score ± SD	Category
When taking the course or lab exams, I mentally refer to (wanting to say when I was studying/ preparing for the exam)	2	0	79	88	28	20	3.92 ± 0.97	+
My study strategies for Bisc 206 are not strictly defined to me only reading over the notes	9	17	20	107	68	0	3.94 ± 1.04	+
While studying for the Bisc 206 test, I like to sketch out what I am trying to learn.	8	52	58	68	24	10	3.35 ± 1.19	d
As of now, I am confident in my study strategies for Bisc 206.	33	74	70	35	7	1	2.60 ± 1.05	+
I find myself daydreaming when studying for upcoming exams for Bisc 206.	25	66	55	59	14	2	2.90± 1.16	-
Studying for Bisc 206 exams is time-consuming.	1	1	7	55	156	0	4.65 ± 0.61	-
I feel as if the study strategies I implemented in this course have helped me to succeed thus far.	34	63	59	57	7	1	2.74 ± 1.12	+
I would try different ways of studying if it meant less time and a better understanding	2	2	8	85	123	1	4.48 ± 0.70	+
I am confident in my ability to distinguish between anatomical structures of the human body.	10	27	81	89	14	0	3.32 ± 0.93	+
The University of Mississippi should offer classes that engage students in studying for a specific course, such as Bisc 206.	4	9	42	81	81	4	4.08 ± 0.98	+

Table 3. Frequency, mean, and standard deviation of Human A&P I student responses to survey 3. Student responses are recorded as (SA = strongly agree, A = agree, N = neutral, SD = strongly disagree, D = disagree, NA = not applicable). Categorization concerning course performance is listed for relevant survey questions (+ = positive, - = negative, d = draw).

Survey Question	SA (1)	A (2)	N (3)	SD (4)	D (5)	Not Applicable (6)	Mean score ± SD	Category
My current grade in this course reflects the successful use of study strategies such as drawing, highlighting, using quizlet, etc.	42	74	57	45	10	3	2.64 ± 1.19	+
My study strategies, such as drawing, highlighting, or other forms of interactive studying, are beneficial to my success in Bisc 206	22	36	56	87	23	7	3.32 ± 1.22	+
The study strategies I have implemented over this semester will continue to be a part of study strategies in the future	7	19	48	115	38	4	3.74 ± 1.06	+
My study strategies for Bisc 206 will be useful for future studies of Anatomy and Physiology.	10	24	54	103	33	7	3.63 ± 1.08	+
My study strategies will enable me to remember most Anatomical structures long-term.	13	35	70	93	15	5	3.33 ± 1.06	+
My study strategies are Bisc 206 are useful but consume more of my time than I would like	5	17	37	104	66	2	3.93 ± 0.98	-
If the University offered an additional "study techniques for Bisc 206," I would enroll	6	27	47	78	70	3	3.81 ± 1.10	?
My study strategies need improvement	8	27	57	84	52	3	3.24 ± 1.16	-
Before Bisc 206, I had never drawn to study, but now I sometimes draw anatomical structures to learn and memorize.	12	60	48	88	16	7	3.26 ± 1.14	+, d
I had no doubts about my study strategies before enrolling in Bisc 206.	16	46	63	75	30	1	3.25 ± 1.12	+

Table 4. Mean score and standard deviation of Human A&P I group C student responses to the drawing exit survey. Student responses are listed as (SD = strongly disagree, D = disagree, N = neutral, A = agree, SA = strongly agree).

Survey Question	SD (1)	D (2)	N (3)	A (4)	SA (5)	Mean Score ± SD
Participating in the drawing sessions has made Anatomy and Physiology topics easier to understand.	0	0	0	3	1	4.25 ± 0.50
Drawing to learn Anatomy and Physiology has kept me more engaged while studying.	0	0	1	2	1	4.00 ± 0.82
I could use my drawing skills to identify anatomical structures.	0	0	0	3	1	4.25 ± 0.50
During the drawing sessions, I felt more engaged in what I was learning.	0	1	1	0	2	3.75 ± 1.50
I am thankful to have participated in the drawing sessions.	0	0	0	1	3	4.75 ± 0.50
The drawing sessions were to draw a model to make the material easier to understand.	0	0	0	0	4	5.00 ± 0.00
I felt as if each drawing session was an important task to complete.	0	0	0	0	4	5.00 ± 0.00
If I was not confident drawing A&P material, I still knew I could finish the drawing and do it well.	0	0	0	0	4	5.00 ± 0.00
My interest in drawing anatomy & physiology material increased with each drawing session.	0	0	1	3	0	3.75 ± 0.50
Models such as drawing are essential tools used throughout science classes to engage better and help students comprehend the material.	0	0	0	2	2	4.50 ± 0.58

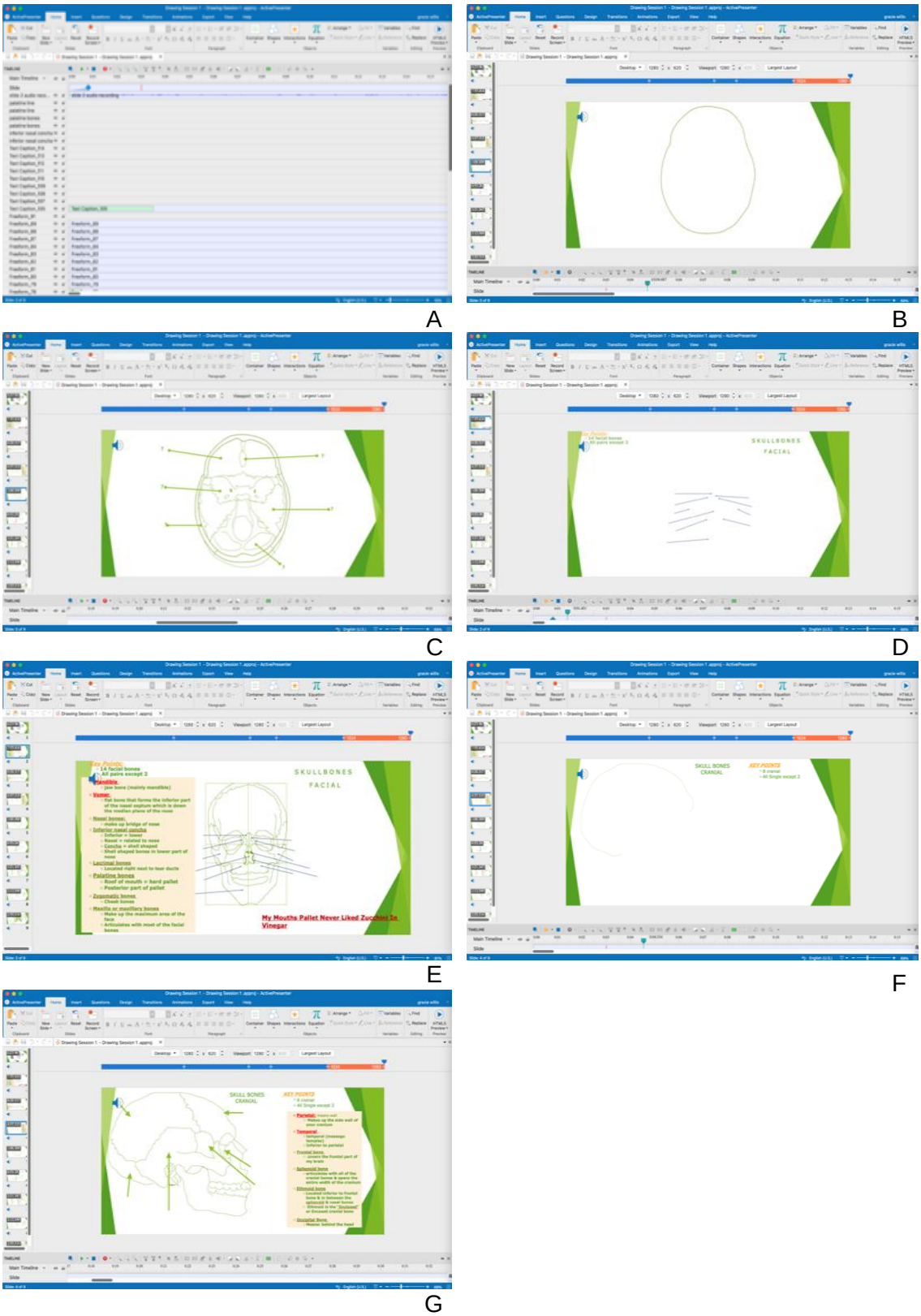


Figure 1. Creation of drawings used in Drawing Session 1 for Group C students enrolled in Bisc 206 at the University of Mississippi in fall 2022.

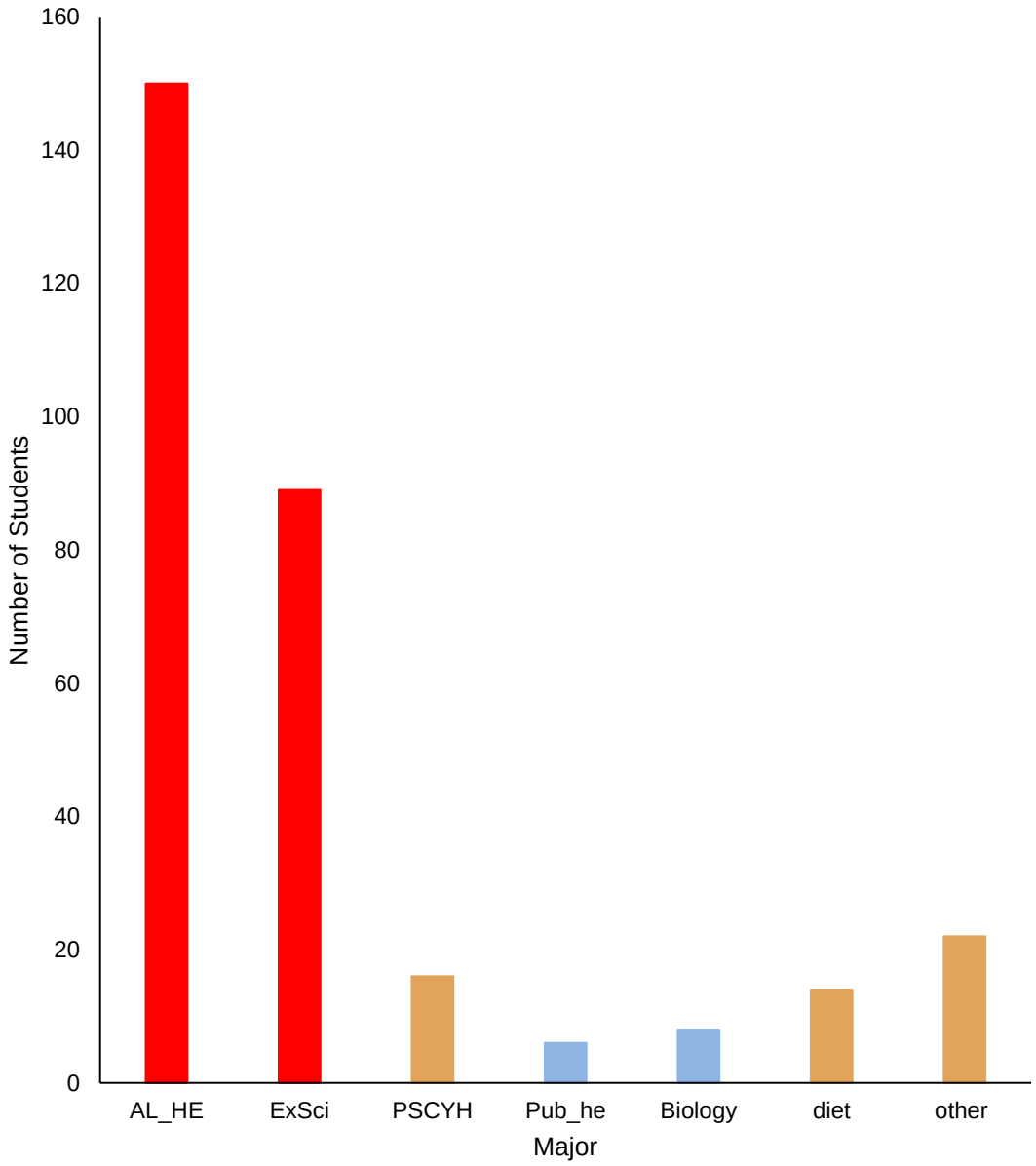


Figure 2. Program majors of students enrolled in Bisc 206 at the University of Mississippi in the fall of 2022.

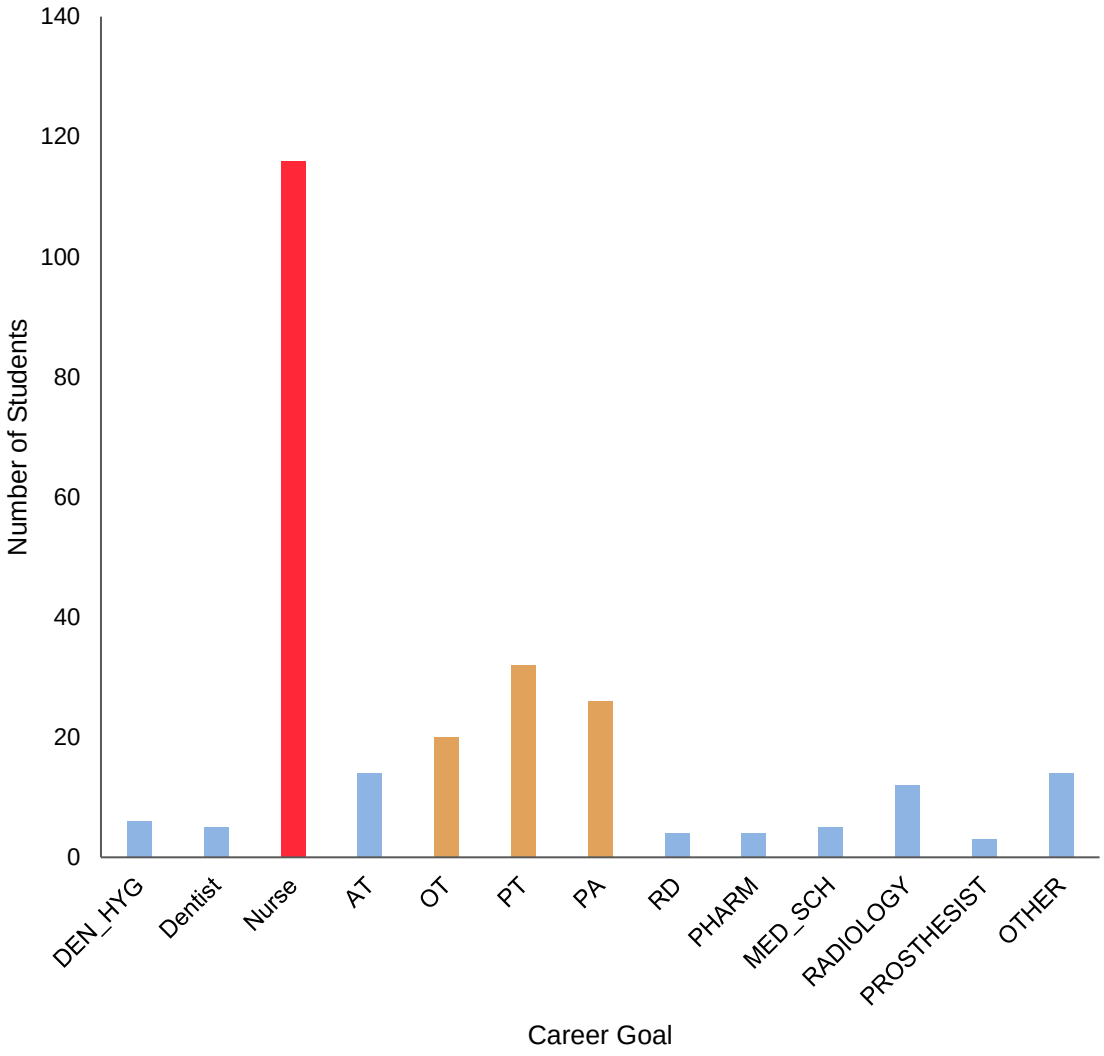


Figure 3. Career goals of Human A&P I students at the University of Mississippi during the fall semester of 2022, with the majority being nursing.

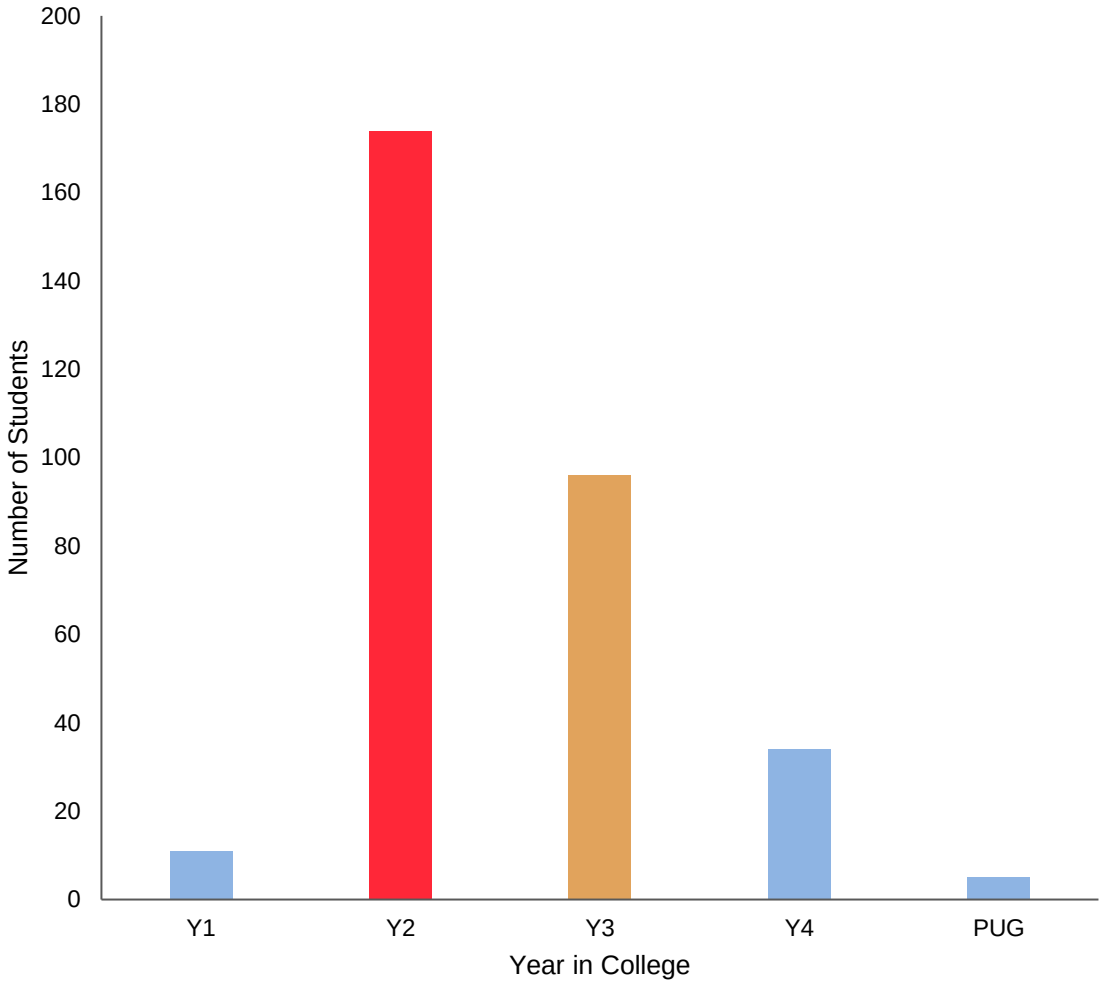


Figure 4. Year in college (Y1 = first year, Y2 = second year, Y3 = third year, Y4 = fourth-year student, PUG = post-undergraduate) of students enrolled in Bisc 206 at the University of Mississippi in the fall of 2022.

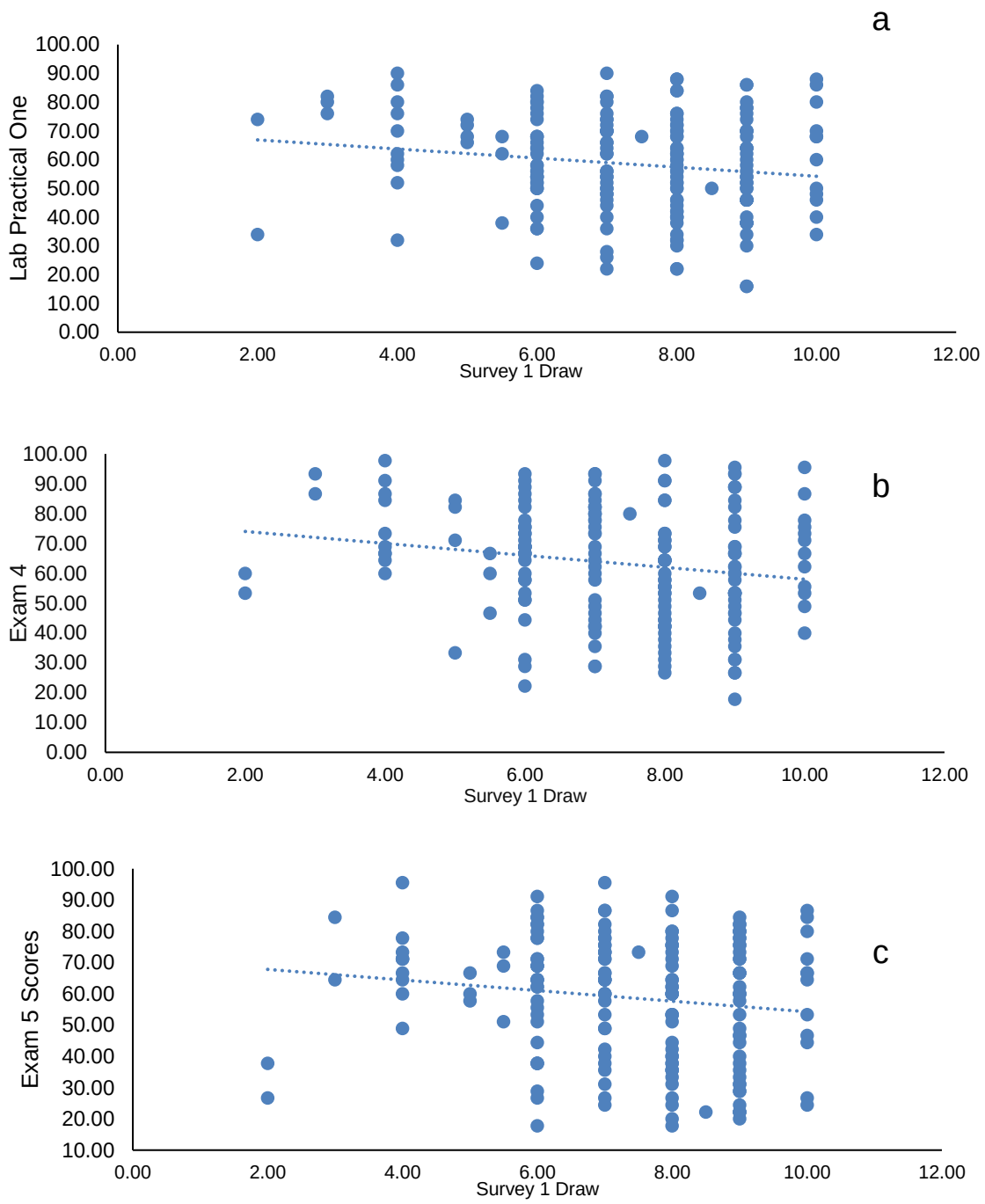


Figure 5. Significant negative correlations between Survey 1 Draw association questions and Lab Practical 1 scores (5a, p = 0.030). Significant negative correlations between Survey 1 Draw association questions and Exam 4 scores (5b, p = 0.016). Significant negative correlations between Survey 1 Draw association questions Exam 5 scores (5c, p = 0.047).

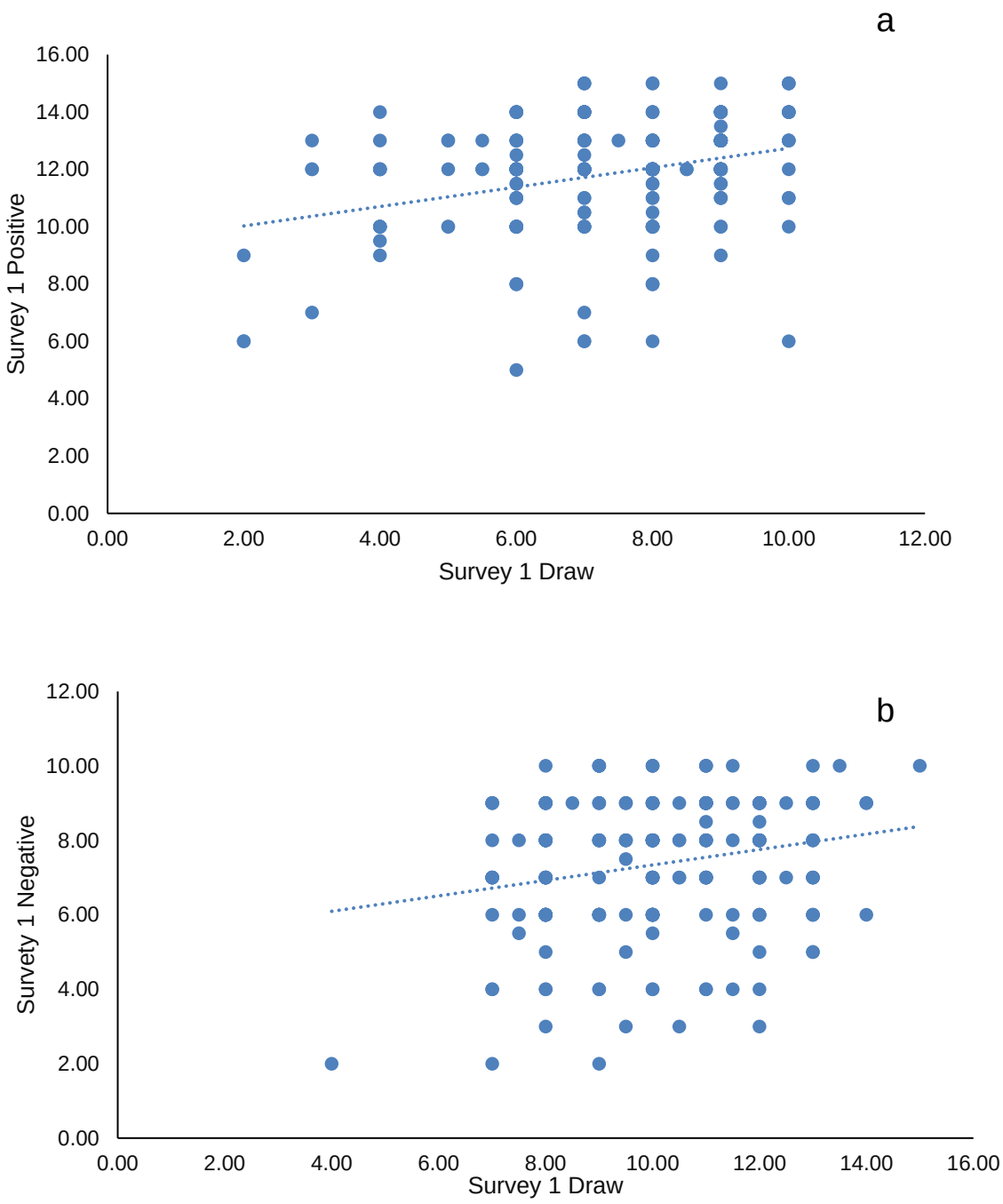


Figure 6. Significant positive correlations between Survey 1 draw association questions and Survey 1 positive association questions (6a, $p < 0.001$). Significant positive correlations between Survey 1 draw association questions and Survey 1 negative association questions (6b, $p = 0.001$).

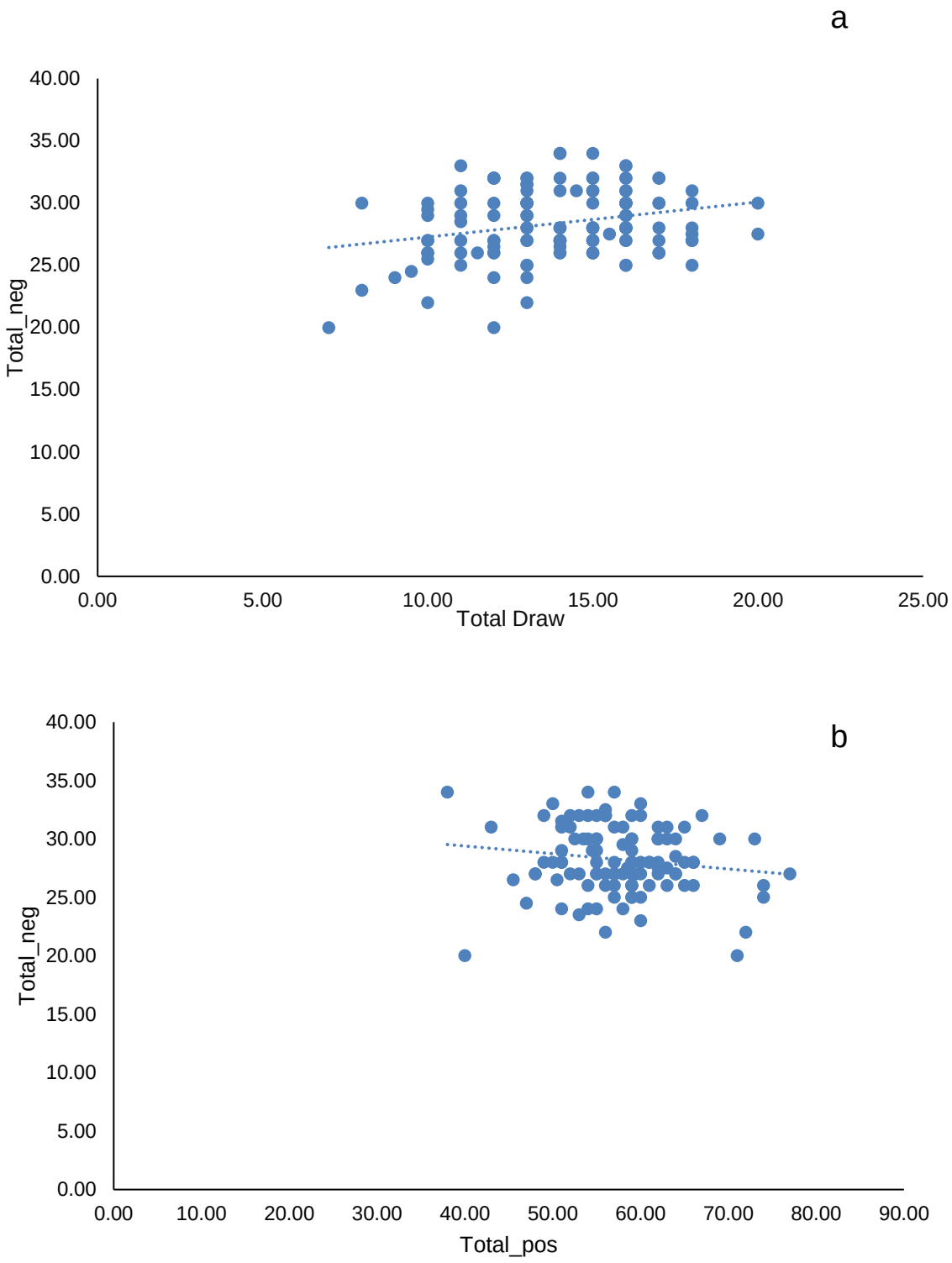
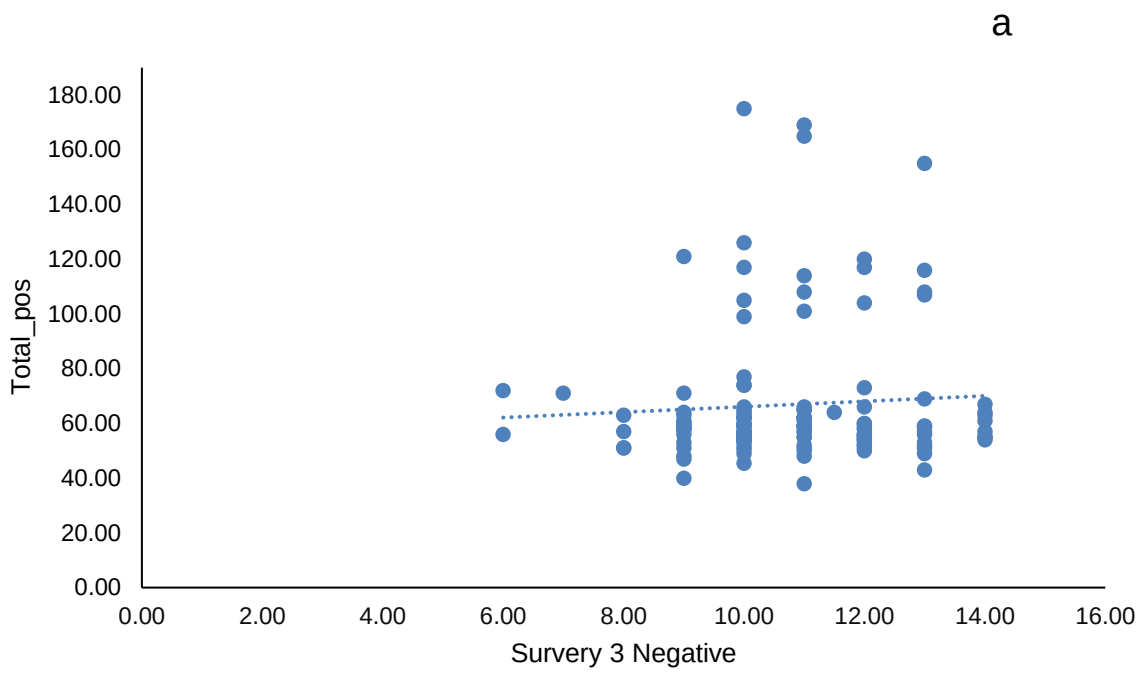


Figure 7. Significant positive correlation between Total_neg and Total_draw association questions (7a, $p = 0.011$). Significant negative correlation between Total_neg and Total_pos survey association questions (7b, $p < 0.001$).



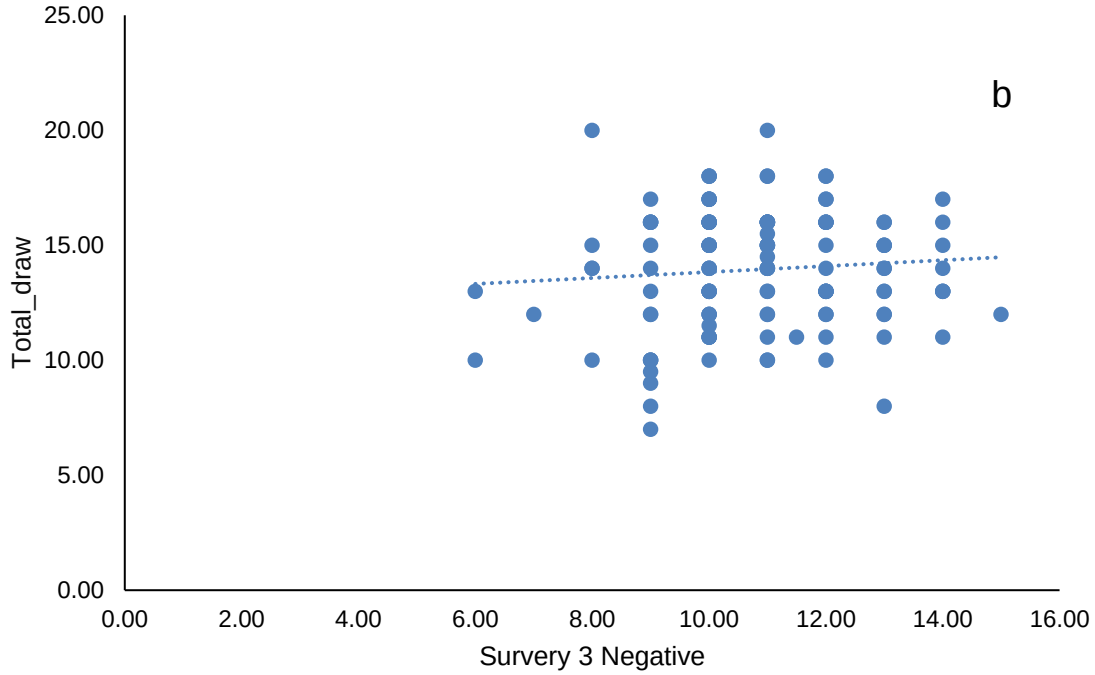


Figure 8. Significant positive correlation between Survey 3 negative association questions and Total_pos association questions (8a, $p < 0.001$). Significant positive correlations between Survey 3 negative association questions and Total_draw association questions (8b, $p = 0.001$).

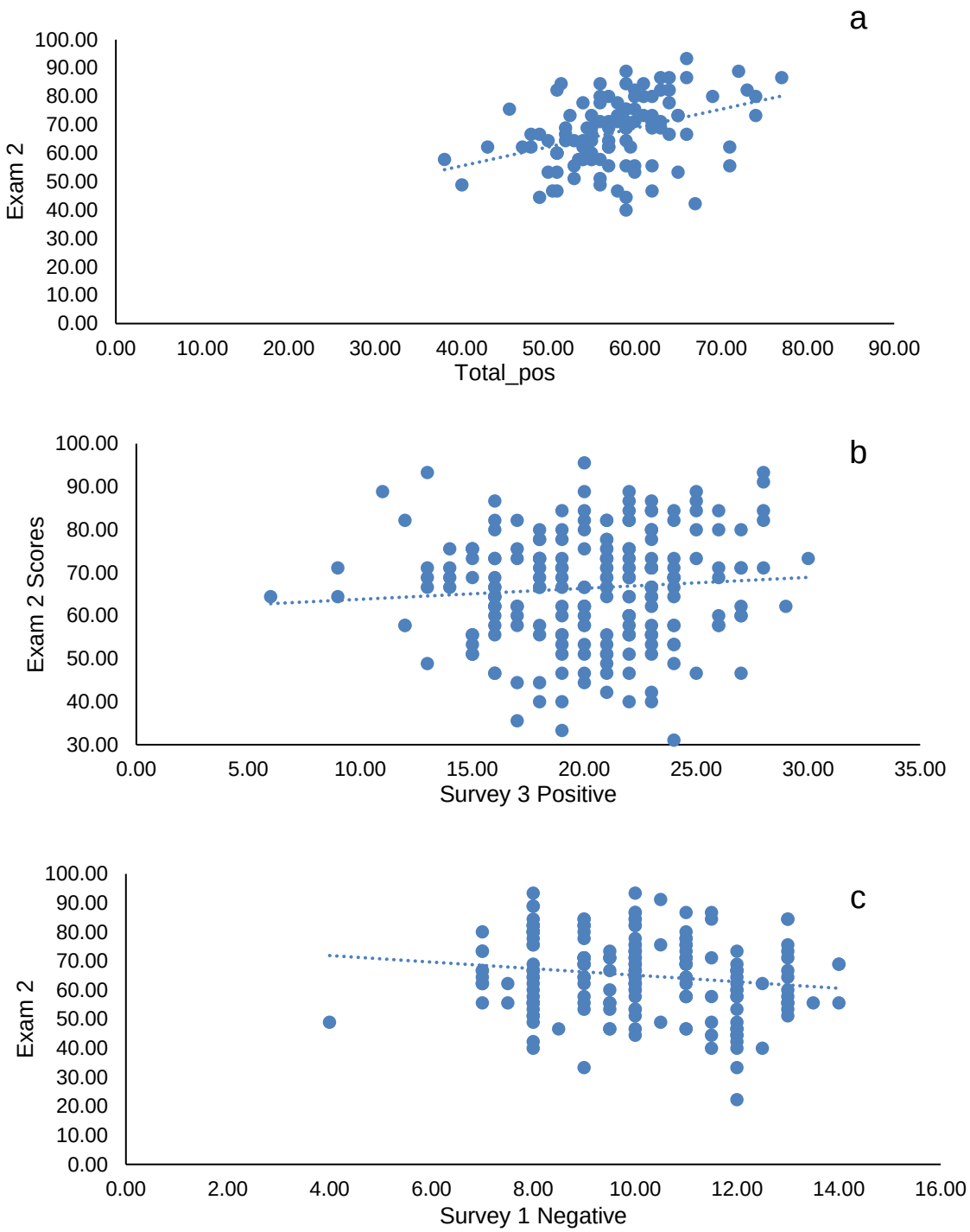


Figure 9. Significant correlations between Exam 2 scores and Total_pos association questions (9a, p = 0.046). Significant correlations between Exam 2 scores and Survey 3 positive association questions (9b, p = 0.017). Significant correlations between Exam 2 scores and Survey 1 negative association questions (9c, p = 0.036).

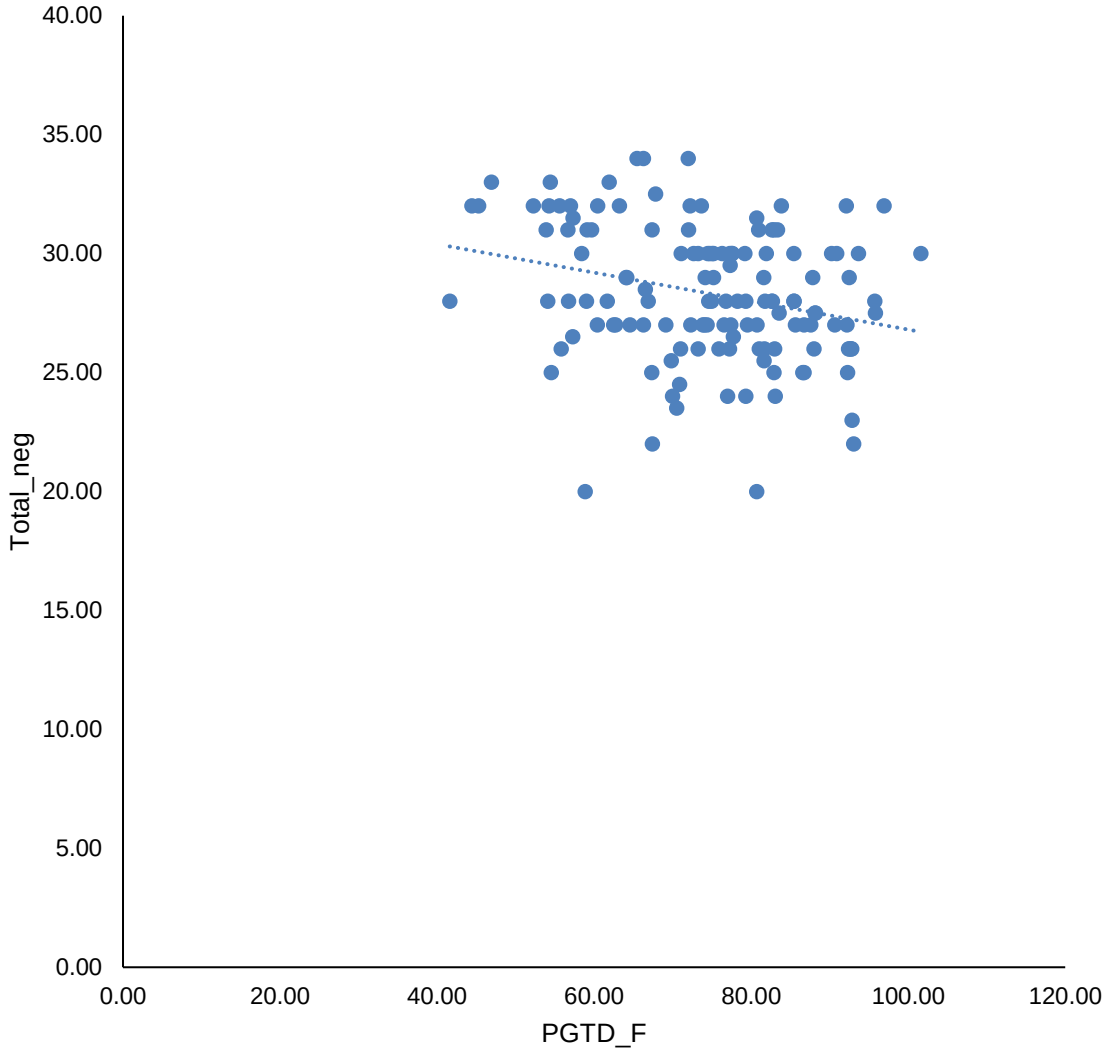
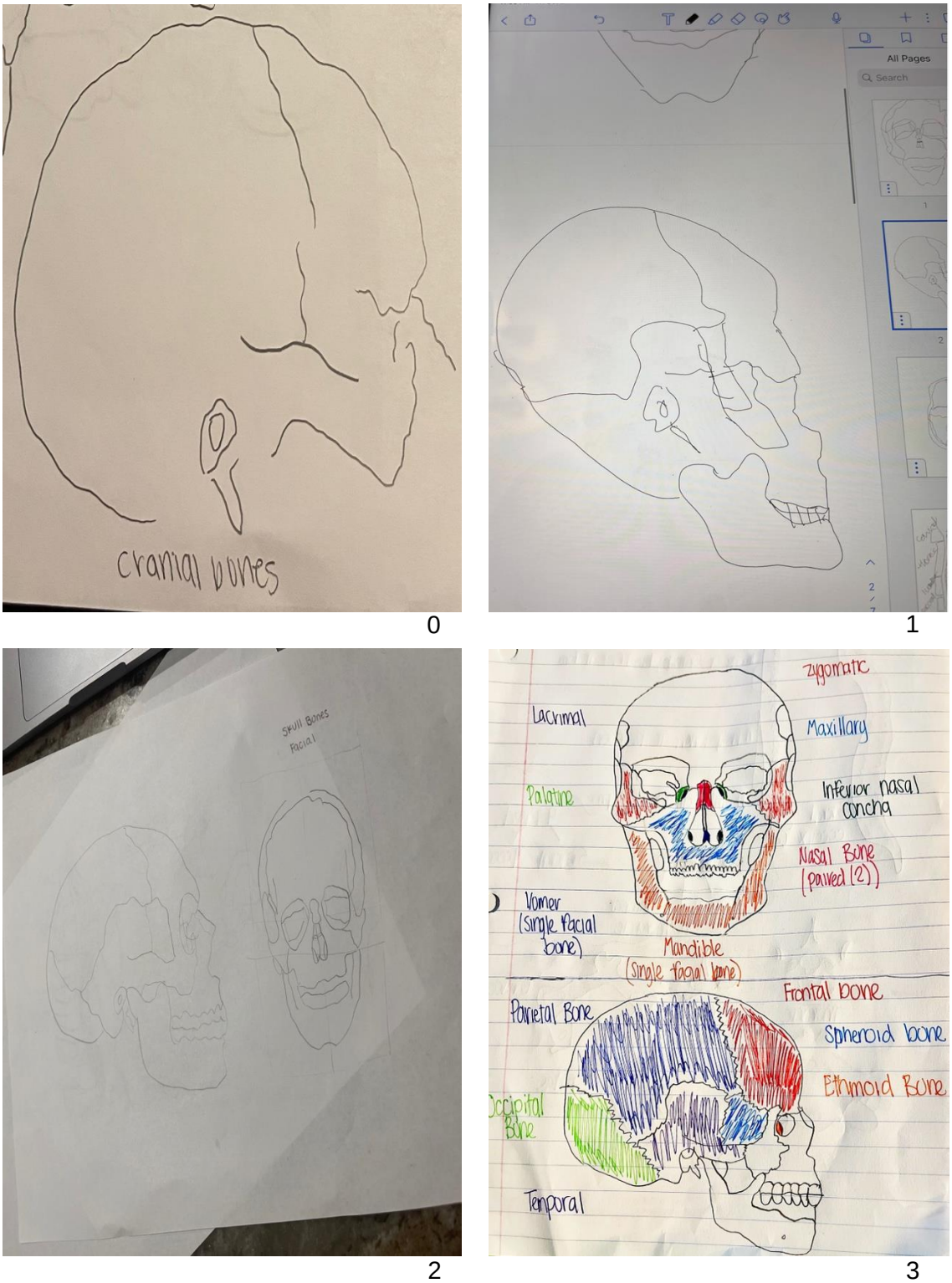


Figure 10. Significant negative correlation between Total_neg association questions and PGTD_F (p = 0.007).



0 1

2 3

Figure 11. Completed scored drawings from student participation in drawing sessions in Bisc 206 at the University of Mississippi in fall 2022. Drawing scores ranging from 0 – 3.