

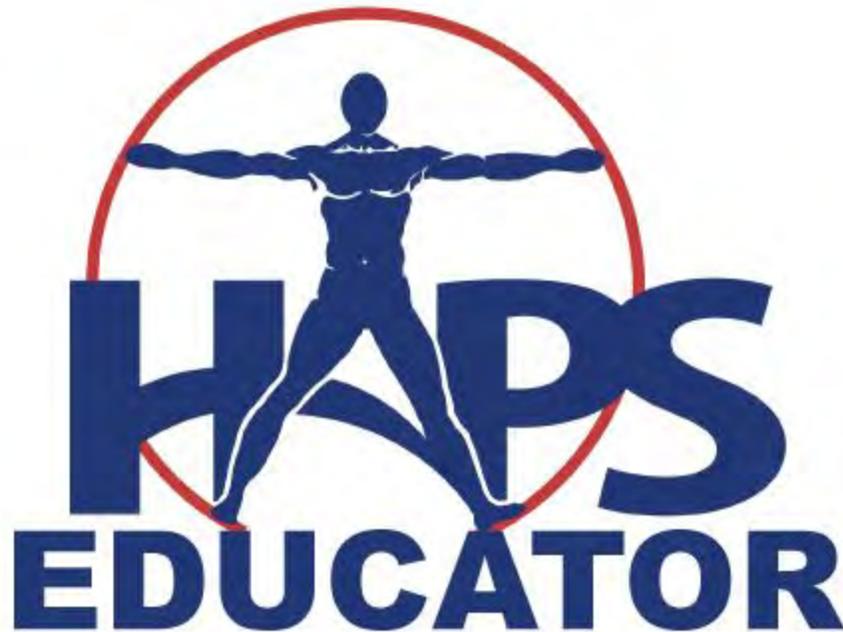
**Does a Student's Academic Major Influence Their  
Perceptions of a Human Anatomy and Physiology Course  
and Ultimately Their Success in the Course?**

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# Does a Student's Academic Major Influence Their Perceptions of a Human Anatomy and Physiology Course and Ultimately Their Success in the Course?

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## Abstract

Students from a variety of majors take human anatomy and physiology courses—usually because they are required for their program of study. Many students find anatomy and physiology classes academically challenging and institutions across the country report high failure and withdrawal rates for these courses. Although research has shown that several factors may contribute to poor student performance, this study focused on the relationship between a student's major and their perceptions about the course to investigate whether these data were reflective of student success rates. Survey data was collected from students in the first semester of a two-semester, systems-based human anatomy and physiology course sequence. While the results did not show a statistical difference in successful completion of the anatomy and physiology course related to academic major, interesting preferences regarding learning styles, study habits, and perceived difficulty of the course were found.  
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**Key words:** anatomy, physiology, academic major, learning styles, study habits, perceptions

## Introduction/Background

Anatomy and physiology (A&P) courses, which are required as foundational courses for many degrees, often act as bottleneck courses because they have some of the highest rates of failure and withdrawal from courses at the undergraduate level (Harris et al. 2004; Higgins-Opitz and Tufts 2014; Hopper 2011; Sturges et al. 2016). Students must learn a large amount of new terminology, memorize a staggering number of anatomical structures, and comprehend the physiological processes of multiple organ systems—typically at the freshman or sophomore level of their education (Sturges et al. 2016; Wehrman et al. 2020). However, studies by Anderton and colleagues (2016a) and Sitticharoon et al. (2014) found that students who mastered the skills needed to succeed in A&P often achieved success in other college courses as well, leading to higher overall grade point averages (GPAs). Considering the importance of GPA to acceptance into many health-related programs and the fact that many programs use A&P grades specifically as a criterion for acceptance, it must be agreed that A&P courses are important for the advancement of students in multiple health professional programs.

Much work has been done to investigate demographic factors that may influence student success in A&P courses including age, gender, and ethnicity (Gultice et al. 2015; Russell et al. 2016; Schutte 2016; Gwazdauskas et al. 2014; Vitali et al. 2020). In addition, academic factors that can predict success have been studied, including foundational skills, placement test scores, and prerequisite requirements (Esmat and Pitts 2020; Forgey et al. 2020; Hull et al. 2016; Shaffer et al. 2018; Schutte 2016; Taylor 2005; Wehrman et al. 2020). In particular, some

researchers have found that students who have completed a prior college-level anatomy or physiology course are more successful than other students when the A&P class grades are calculated (Esmat and Pitts 2020; McCleary et al. 1999; Shaffer et al. 2018; Wehrman et al. 2020).

Several studies have looked at the implications of a student's chosen major and how this might be involved in student success — particularly regarding prerequisite courses specific for each major and the level of motivation to complete the major and perhaps be successfully admitted into a health-related program of study (Esmat and Pitts 2020; Higgins-Opitz and Tufts 2014; Reinke 2019; Rompolski et al. 2016; Schutte 2016; Sturges et al. 2016; Wehrman et al. 2020). For example, studies regarding the exercise science major, also known as sport science or exercise and sport science, suggest that students in this major may be less successful in A&P than students in other majors (Esmat and Pitts 2020; Higgins-Opitz and Tufts 2014; Reinke 2019; Schutte 2016). The same inference has been made regarding students in two- and four-year allied health degree programs, such as nursing, dental hygiene, and other programs with similar course requirements (Rompolski et al. 2016; Schutte 2016). Other studies have shown that students in pre-professional majors, such as biology or health science, have been more successful in A&P courses compared to their classmates in other majors (Gwazdauskas et al. 2014; Schutte 2016).

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Researchers have considered the relationship between academic performance in A&P and students' perception of these courses, including their motivation to study and their initial perception related to the difficulty of the courses (Royse et al. 2020; Slominski et al. 2019; Sturges and Maurer 2013; Sturges et al. 2016). To evaluate student perceptions, several measures of study habits may be evaluated, including learning styles or strategies, time devoted to study, study techniques, and perceived difficulty of the course, both before and after completion of the course (Breckler et al. 2009; Fleming 1995; Husmann and O'Loughlin 2018; Knight and Smith 2010; Quinn et al. 2017).

Learning styles are described as a set of factors, behaviors, and attitudes that facilitate learning for an individual in a given situation (Quinn et al. 2017). The concept and existence of student learning styles has been a subject of great discussion and debate in educational research, likely due to a lack of correlation among teaching methods, learning styles, and student outcomes (Husmann and O'Loughlin 2018).

Learning styles group common ways that people learn and there are as many as 71 different learning style tools and theories (Knight and Smith 2010; Quinn et al. 2017). For example, student learning may be classified according to the sensory modalities that one most prefers to use when studying material. One such classification scheme uses Fleming's VARK instrument (Fleming 1995), which categorizes learning preferences as visual (V), auditory (A), reading-writing (R), or kinesthetic (K). However, even its developer noted that there are limitations to the scope, validity and reliability of the VARK questionnaire (Breckler et al. 2009; Fleming 1995).

The VARK model was originally developed as a tool to promote discussion and reflection on learning styles (Fleming and Mills 1992; Husmann and O'Loughlin 2018). Fleming reminds us that the VARK was never meant to be a diagnostic tool. Indeed, only 15.5% of all students were able to accurately self-predict their own VARK result (Breckler et al. 2009; Husmann and O'Loughlin 2018). However, the VARK learning philosophy at least offers and encourages teachers to acknowledge that there are learning differences and to make efforts to address some of these differences in their classrooms by attempting a wide range of teaching approaches (Dunn and Griggs 2003).

At the undergraduate level there is a noticeable lack of research on learning style preferences of students enrolled in gross anatomy classes. The literature in this area is mostly focused on learning style preferences among medical students (Anderton et al. 2016b; Knight and Smith 2010; Quinn et al. 2017). The purpose of this research study was to address the following research questions in the context of survey data from students in a variety of different majors and academic plans enrolled in the first semester of a two-semester, systems-based A&P course sequence:

1. Does a student's major or academic plan influence their overall success in an A&P course?
2. Does a student's major or academic plan influence their learning style preferences, study techniques, and time spent studying when taking an A&P course?
3. Does a student's major or academic plan influence their perception of the difficulty of an A&P course?

## Methods

### *Study Context and Participants*

This project was conducted at Frostburg State University (FSU), which is a comprehensive, regional public liberal arts university in Western Maryland. FSU is part of the University System of Maryland (USM) and is the only four-year public institution in the state west of the Baltimore-Washington metropolitan area. It serves as the educational center for Western Maryland and surrounding counties in Pennsylvania and West Virginia and typically enrolls 4,700 to 5,000 undergraduate and graduate students each year.

In this study, students enrolled in human A&P I, which is the first of a two-semester, systems-based human anatomy and physiology course sequence, were surveyed at the beginning and just before completing the course in fall 2016 and fall 2017. There were a total of 306 students enrolled in both sections at the beginning of the two semesters and 282 students completed the course with 24 student withdrawals. Students who took this class were required to have the first introductory biology course (Biology 149 at FSU), or the equivalent, before they were permitted to enroll, so most were sophomores (n=163). However, some were freshman (n=46) who had completed an equivalent course prior to enrolling at FSU, and some were juniors (n=76) or seniors (n=21). The project was approved by the Frostburg State University Institutional Review Board (FSU Project #H2016-001), and informed consent was obtained from all participants. Student participation was voluntary and anonymous and had no influence on course grades.

### *Description of Survey Questions*

All students in the class were asked to complete two anonymous, in-person, paper surveys (Appendix 1). There was no time limit for either survey. The initial survey was administered at the beginning of the semester during the second week of class, and the final survey was done near the end of the semester during the second-to-last week of class before final exams. Note that the final survey was completed after the course withdrawal deadline (week 10), so students who withdrew from A&P I in 2016 and 2017 (n=24) were not represented. A total of 294 students from both sections in both years completed the initial survey (96.08%) and a total of 248 students from both sections in both years completed the final survey (87.94%).

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The first set of survey questions, classified as *descriptive* questions, asked about a student's major or academic plans, career goals, and if they had taken any previous A&P courses at the college level. At FSU, students in several different majors and academic pathways take both A&P I and II. The majors include biology, chemistry, health science (pre-medical, pre-dental, pre-physician assistant, pre-physical therapy), exercise and sport science, and athletic training. Students with other academic plans include transfer students (pre-nursing, pre-dental hygiene, pre-occupational therapy), and students enrolled in other majors, such as psychology, or undecided students, that take the course for a variety of personal and academic reasons. Career options that students could select included personal trainer, athletic trainer, health profession at the bachelor's level, master's level, or doctorate level, research or academic position at the master's level or doctorate level, or 'other' for those with other career goals or who were still undecided.

In the final survey, students were asked if they changed their major or academic plan and/or career goal during the semester. It's important to note that the population of students at FSU is represented by differences in age, gender, and cultural and educational backgrounds; however, we did not collect demographic information regarding these parameters on either survey to help maintain student anonymity.

The second set of survey questions, classified as *preference* questions, asked about a student's learning style preferences, study techniques, time spent studying, and perceived difficulty of the course. Students were asked about their learning styles, or modalities, by using those outlined in the textbook used for the course (Amerman 2015). Similar to the VARK assessment, our survey included four sensory modalities: Visual/Verbal, in which learners fare best when reading written material such as notes and textbooks and looking at diagrams, illustrations, and visual multimedia presentations (such as animations); Visual/Nonverbal where learners best understand concepts through the use of diagrams, illustrations, and other visual media without text; Auditory/Verbal, in which a learner does well when listening to lectures, presentations, or when discussing material with a group (these individuals tend to prefer text-based materials rather than visuals); and Tactile/Kinesthetic where the learner thrives in an environment where he or she can physically manipulate a specimen (these students excel in practical settings, including the A&P lab) (Amerman 2015).

Unlike the VARK assessment, which compares the proportion of multimodal learners (those that have strong preferences to using multiple learning styles) to unimodal learners (those that have a single, strong preference), the survey used in this study attempted to limit students' responses to the single learning style they most strongly preferred. In the final survey, students were also asked if they believed that they had a

different learning style than they selected on the initial survey. Two additional questions asked about students' plans to use the same study techniques that they used for other courses, and how much time they planned to study for the A&P I course compared to other college courses. Students were asked these questions again on the final survey to see if they changed their answers. Finally, on the initial survey, students were asked how difficult they thought the class would be, and on the final survey, students were asked how difficult they actually found the class to be. This data was collected using a scale of 1-10, with 1 being very easy and 10 being the most difficult.

### Data Analysis

For the purpose of evaluating the data relative to previous studies and for statistical comparisons, students were sorted by major or academic plan into three academic groups: *Kinesiology* (n=120), which included exercise and sport science and athletic training majors; *Science* (n=142), which included biology, chemistry and health science majors; and, *Miscellaneous* (n=44), which included students with alternative academic pathways, such as transfer students, other majors, and undecided students.

Student success was evaluated by comparing the final grades of students by their academic group and by their class standing. Frostburg State University uses the standard letter grading system of A, B, C, D, F, and W for students who withdraw before the class is completed. No "+" or "-" additions to the letter grades are reported. Students who received D, F, or W grades were considered unsuccessful in the course. Graphic results comparing initial and final survey data from the three academic groups are reported as percentages to account for the reduced number of students completing the final survey. Chi-square tests for independence were used to compare initial and final survey responses between the three academic groups and to compare student success between the three academic groups and by class standing. Significance was set at  $p \leq 0.05$ .

## Results

### Descriptive Questions

#### Academic Major or Plan

The percentage of students enrolled in each major or academic plan did not significantly change ( $p = 0.91$ ) from the initial to the final surveys (reported as initial percent; final percent). The most popular majors or plans were exercise and sport science (31.3%; 26.2%) and health science (27.0%; 28.5%), followed by biology (18.3%; 18.8%), transfer students (8.7%; 9.6%), athletic training (7.3%; 8.5%), 'other' (5.3%; 6.5%), and chemistry (2.0%; 1.9%). It should be pointed out that in 2016 and 2017 when the surveys were completed, the athletic training major was offered at the bachelor's level at FSU. It has since become a master's level program and students enroll in

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the exercise and sport science undergraduate major to prepare them for the graduate level athletic training curriculum. The fact that there were no significant changes in number for any major from the initial to final surveys justified our use of academic groups for statistical analyses.

Career Goals

Overall, the most popular career goals in both the initial and final surveys (reported as initial percent; final percent) were those in the health professions, particularly at the doctorate level (51.7%; 46.6%) and master's level (20.5%; 19.0%). These were followed by health professions at the bachelor's level (7.9%; 11.5%), 'other' (6.3%; 8.6%), personal trainers (6.9%; 6.1%) and athletic trainers (4.1%; 5.7%). Very few students selected research or academic positions at the doctorate (1.6%; 1.1%) or masters levels (0.9%; 1.4%). Again, the percentages in each career goal did not change significantly ( $p = 0.59$ ) from the initial to the final survey.

When comparing the career goals of each academic group, there were differences in the popularity of the options. For example, only students in the Kinesiology group selected personal and athletic trainer careers. The few students who selected one of the research or academic options were in the Science group and the majority of students who selected health professions at the bachelor's level were in the Miscellaneous group. Students in both the Kinesiology and Miscellaneous groups also selected 'other' as possible career options.

Previous Anatomy and Physiology Courses at the College Level

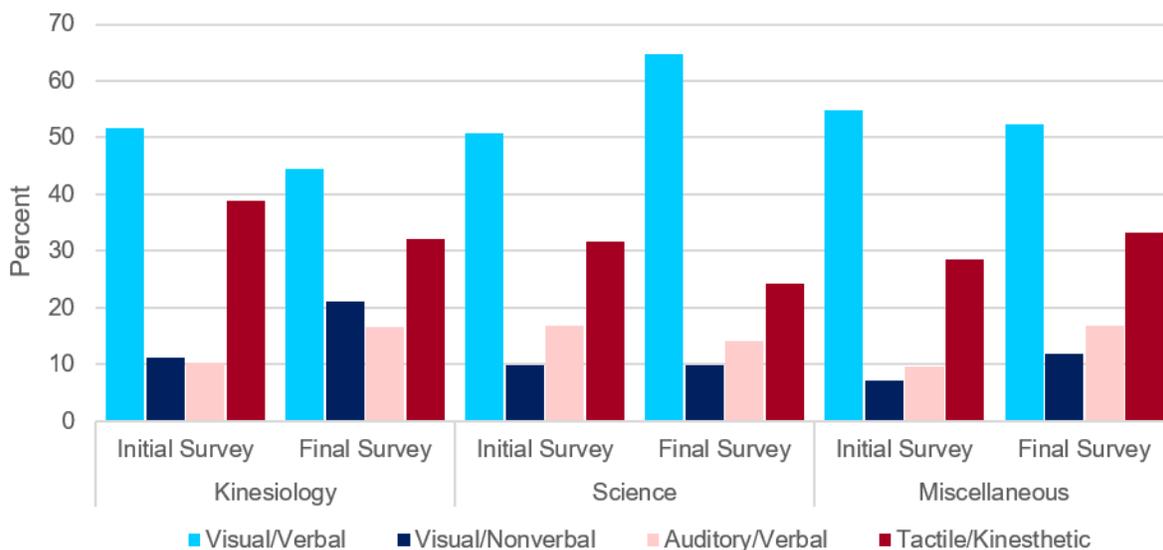
Students were asked if they had taken a previous A&P course at the college level and the majority replied that they had not.

When comparing the responses by academic group, there was a statistical difference ( $p = 0.003$ ) with 84.3% of Science students reporting that they had not taken a prior A&P college course, compared to 69.6% of the Kinesiology students and 62.2% of the Miscellaneous students. Students were not asked whether the prior A&P course was at FSU or another institution or whether they were repeating the course. No questions were asked about prior A&P courses taken in high school.

Perspective Questions

Learning Style Preferences

The most popular learning style preference (LSP) in both the initial and final surveys across all three academic groups was Visual/Verbal. More than half of all students selected this modality on the initial survey. In the final survey, the percentage of Kinesiology students who preferred Visual/Verbal fell about 7% with a smaller decline in the Miscellaneous group. This is in contrast to the Science group, where nearly 65% of students on the final survey preferred Visual/Verbal compared to 50% on initial survey. The second most common LSP was Tactile/Kinesthetic on both surveys in all three academic groups, with Kinesiology students showing a slightly stronger preference for this learning modality as compared to the Science and Miscellaneous groups although the preference did increase in the Miscellaneous group in the final survey. Coming in third and fourth, respectively, for both the Science and Miscellaneous groups were Auditory/Verbal and Visual/Nonverbal on both surveys. In contrast, students in the Kinesiology group preferred Visual/Nonverbal over Audio/Verbal in both surveys (Figure 1).



**Figure 1.** Learning style preferences by academic group expressed as percent of students completing initial and final surveys.

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It is noteworthy that, although asked to provide “*which method of learning best describes your learning style*” on both surveys (reported as initial percent; final percent), a proportion of students in all three groups selected multiple learning styles. Although this increase was not statistically significant ( $p=0.44$ ), the largest increases in multimodal learners were in the Science (9.9%; 18.8%), and Miscellaneous (9.5%; 16.7%) groups, where those selecting multiple learning style preferences nearly doubled. The percentage of students in the Kinesiology group selecting multiple learning styles (12.1%; 14.4%) was similar in both surveys.

**Study Techniques**

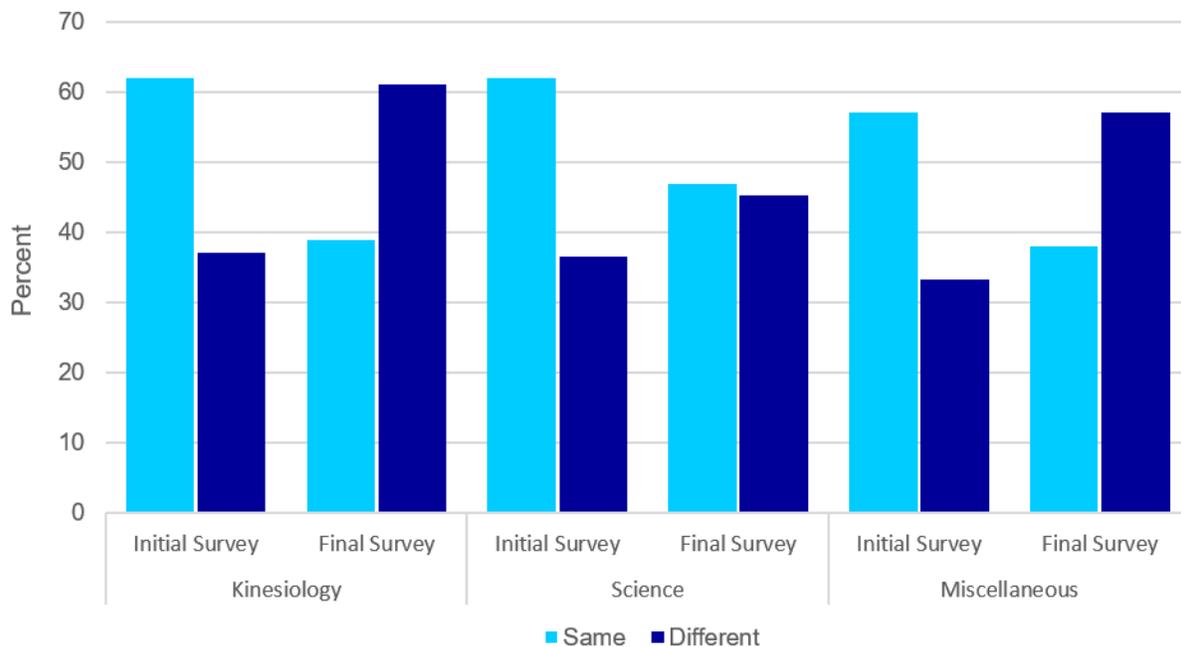
In the initial survey, students were asked if they planned to use the same study techniques for A&P I that they had used in other college classes. While nearly 60% of all students predicted that they would, in the final survey, only about 40% of all students did ultimately report using the same study techniques in A&P I as they had in other college courses (Figure 2). Although the percentage of Science students appeared most likely to maintain the same study techniques, there was no statistical difference ( $p = 0.052$ ) when comparing their initial and final responses. Meanwhile, over 20% of

Kinesiology students reported using different study habits in A&P I than they had predicted, which was statistically significant ( $p = 0.0007$ ). A similar trend was seen with the Miscellaneous students, which was also statistically significant ( $p = 0.04$ ).

**Study Time**

In the initial survey, students were asked to predict the amount of study time they would devote to A&P I compared to other college courses they had taken. Students in all academic groups overwhelmingly reported (80% or above) that they would spend more time studying for A&P I than they had for other courses. No student predicted that the time would be less. Less than 10 per cent of students in each of the Kinesiology and Miscellaneous groups predicted that they would spend about the same time studying for A&P I as other classes whereas almost 20% of Science students believed that they would invest the same amount of time (Figure 3).

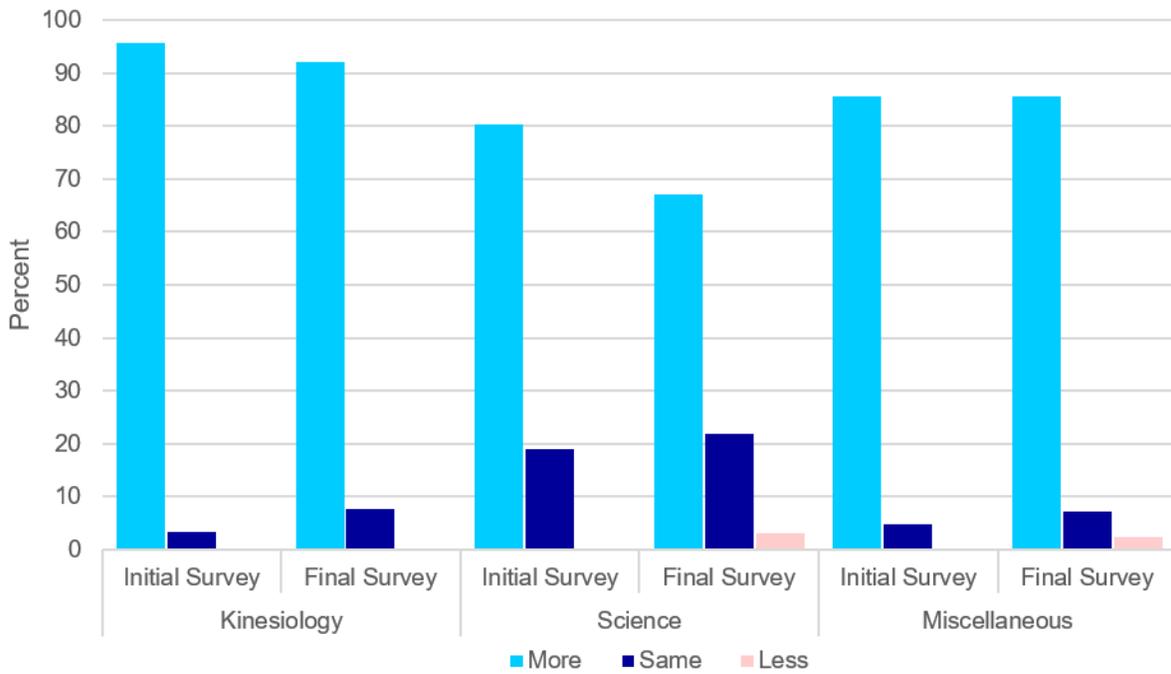
When asked on the final survey how much time they actually spent studying A&P I compared to other courses, over 90% of Kinesiology students did report studying more for A&P I than for other classes and those that invested about the



**Figure 2.** Study techniques (same or different) compared to other college courses by academic group. Percent of students completing initial and final surveys.

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same amount of time increased slightly (Figure 3). Students in the Miscellaneous category more accurately predicted that they would spend more time studying A&P I, although some students did report actually spending less time with A&P I than other courses. Students in the Science group reported that they spent less time studying A&P I compared to other classes than they initially predicted. However, within the academic groups, there was no statistical difference between the initial and final surveys (Kinesiology  $p = 0.18$ ; Science  $p = 0.30$ ; Miscellaneous  $p = 0.67$ ).



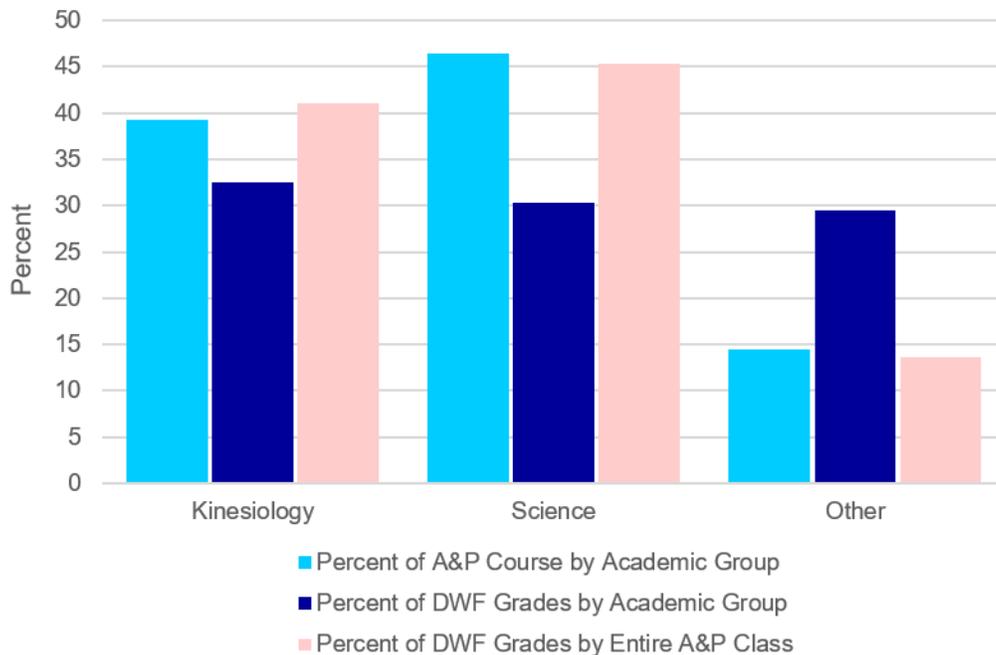
**Figure 3.** Study time (more, less or the same) compared to other college courses by academic group. Percent of students completing initial and final surveys.

Perceived Difficulty of the Course

In the initial survey, students were asked to rate on a scale of 1 to 10 how difficult they expected the course to be with 1 being very easy and 10 being most difficult. Similarly, in the final survey, students were again asked to rate the difficulty of the course and whether they felt the course was easier or harder than they had thought it would be. The most frequently chosen numerical answer, or mode, on both the initial and final surveys among all academic groups was 8/10. This result is interesting considering that 60% or more of students from all three academic groups stated that they felt the class was harder than they thought it would be.

Student Success Rates

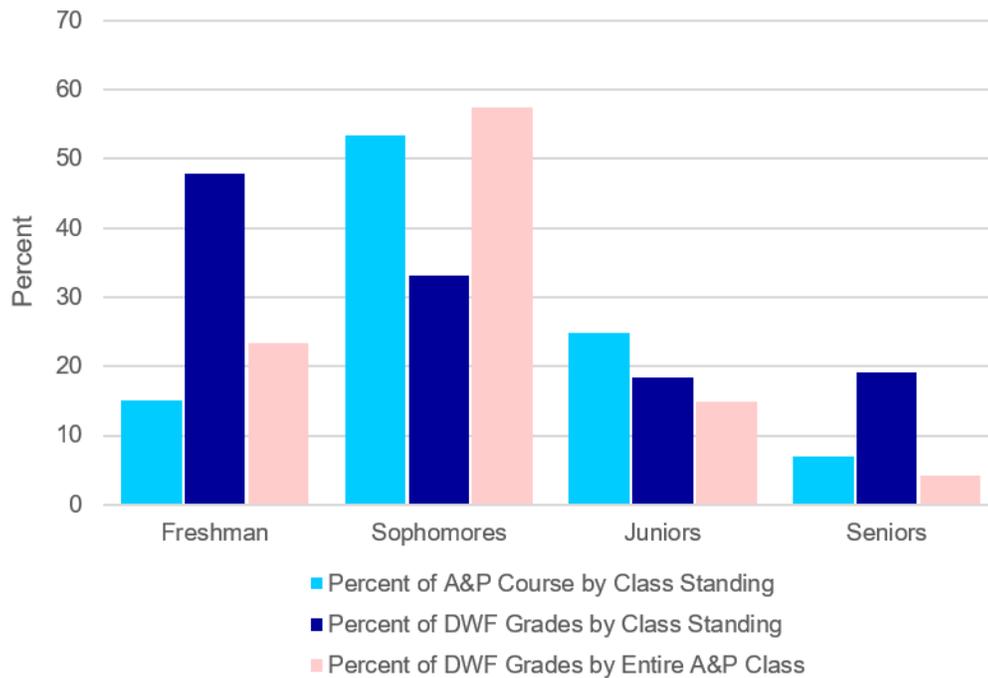
As reported previously, a total of 306 students were enrolled in both lecture sections of A&P I in 2016 and 2017. A total of 95 students (31.0%) were unsuccessful and either withdrew 'W' or received a 'D' or 'F' grade for the course. When comparing the DWF grades by academic group (close to 30% for each group), no statistical significance ( $p = 0.90$ ) was found (Figure 4).



**Figure 4.** Class composition (kinesiology, science, other) and percent students with DWF (grade of D, withdrew from course, grade of F) by academic group and as percent of the entire A&P class.

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The majority of students in A&P I were sophomores, followed by juniors, then freshman, and, finally, seniors. Although comprising only 15% of the course, freshmen accounted for nearly a quarter of the course DWF grades. Almost 48% of freshmen were unsuccessful in the course, followed by sophomores at just over 33% and seniors and juniors at about 19% (Figure 5). Class-standing was found to be correlated with successful completion of this A&P course ( $p = 0.004$ ). However, students were not asked to self-identify by class standing so no survey data could be directly related to this parameter.



**Figure 5.** Class composition by standing (freshman, sophomore, junior, senior) and percent of students with DWF (grade of D, withdrew, grade of F) by class standing and as percent of the entire A&P class.

## Discussion

### Descriptive Questions

#### Academic Major or Plan

As is the case with many institutions, the A&P I course at FSU is a required course for students in a variety of academic majors and plans, so we were interested to see if students changed their major or plan after taking the course. While some students did change their major or plan during the semester, the numbers were not statistically significant

### Career Goals

The most popular career goals in both surveys were those in the health professions, which is not unexpected from students enrolled in a human anatomy and physiology course. In addition, certain career goals that were selected exclusively or almost exclusively by specific academic groups also were expected. Even though there were no statistically significant differences between the surveys, a trend toward a decrease in selecting the option of health profession at the doctorate level by Kinesiology and Science students may indicate that some students were reconsidering their career options after taking the A&P I class.

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### Previous Anatomy and Physiology Courses at the College Level

While most of our students had not taken a previous A&P course at the college level, there was a statistical difference regarding the number of students by academic group. Unfortunately, we do not know if the students who had taken a prior college level A&P course were repeating the course or had taken a different A&P course, such as a single-semester, essentials of A&P course. It is noteworthy that there was no significant difference in student success rates for any of the academic groups which suggests that a prior A&P course at the college level was not helpful in this regard. It is unclear, then, whether our results agree or disagree with other studies (Esmat and Pitts 2020; McCleary et al. 1999; Shaffer et al. 2018; Wehrman et al. 2020).

### Perspective Questions

#### Learning Style Preferences

Our findings on preferred learning styles among students in A&P I are contrary to other studies reporting that a majority of students enrolled in A&P prefer a kinesthetic, or hands-on approach, to learning (Anderton et al. 2016b; Breckler et al. 2009; Carnegie 2008; Hsieh et al. 2012; Meehan-Andrews 2009). Students in our study most commonly selected a Visual/Verbal learning style ahead of a Tactile/Kinesthetic approach. However, only about 5.6% of students overall noted that they identify with a different learning style preference altogether than what they had indicated on their initial survey. It was noted that students in the Kinesiology and Miscellaneous groups had learning style preferences that more closely mirrored each other on the final survey as compared to the Science group. However, with no apparent significant statistical correlation between groups in reference to learning style preferences or course success, our study aligns with other authors who argue that learning style preferences do not predict course performance (Farkas et al. 2016; Gravenhorst 2007; Hsieh et al. 2012; Husmann and O'Loughlin 2018; Quinn et al. 2017).

Breckler et al. (2009) stated that, although limited in scope and reliability, knowledge of student learning preferences is important for reasons of pedagogy. Quinn and coworkers (2017) argued that an understanding of students' preferred learning styles can guide course design but it should not be implemented in isolation and can be strengthened (or weakened) by concurrent use of other tools. Assessment of student learning style preferences may be useful in aiding instructors to develop their courses in a way that best engages the diversity of learning styles likely held by their students.

#### Study Techniques

Goldman and Hudson (1973) found that undergraduates majoring in the sciences used different study strategies compared to non-science majors, an observation that agrees with the results of this study. Nearly a quarter of students in the Kinesiology and Miscellaneous groups indicated that they

ultimately employed different study techniques in this A&P I course than they had initially predicted. In contrast, Edmunds and Richardson (2009) found no variation in the study habits of undergraduates. They suggested that study habits are more strongly related to the student's overall conceptions of learning than to the contextual clues of the subject matter.

As noted, students within the Science group were more likely to maintain the same study techniques compared to students in the Kinesiology and Miscellaneous groups. Literature suggests a negative correlation between changing study habits between courses and final anatomy grade (Husmann et al. 2015). Similarly, Ward and Walker (2008) found that students who used a consistent approach to studying achieved higher grades than those who attempted to change. This may indicate that students who understand their own learning style preferences can organize course information into the style that they most prefer (Dobson 2009). In a study examining the relationship between learning style awareness and academic achievement in community college students, there was a significant difference in academic achievement in favor of those aware of their predominant learning style (Cook 1991).

An exception to this may be transitioning from unimodal to multimodal learning. Hu and colleagues, in their 2017 study of learning style preferences and academic performance in first year medical school students, found that doing so allowed students who were struggling to improve their academic performance. This study, along with several others, suggests that multimodal preferences are most common among science and pre-health professions students (Breckler et al. 2009; Goldman and Hudson 1973; Husmann et al. 2015). The number of such students in our study reporting multimodal learning preferences nearly doubled from the initial to the final survey.

Interestingly, Husmann and colleagues (2015) found that most students did not report study strategies that were consistent with their VARK assessment nor did their performance correlate with their VARK score in any category. Students also did not use VARK to make changes to their study strategies. Even those students who did use study strategies consistent with their VARK dominant category had no greater success in the course.

Though students in the Science group were more likely to maintain the same study techniques (a predictor of success according to the literature cited above), they were statistically no more likely to achieve success in this course than students in the Kinesiology and Miscellaneous groups. Similarly, although the number of students indicating multimodal learning style preferences nearly doubled among the Science and Miscellaneous groups (another predictor of success), those groups were again statistically no more likely to achieve

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success in the course. However, it is unclear whether or not individual students who did maintain consistent study habits or embraced multiple learning styles enjoyed higher grades.

#### Study Time

Our results showing that Science students spent less time studying for A&P I than they predicted could indicate that students in the Science group, many of whom were likely enrolled concurrently in other demanding science courses such as organic chemistry, may not have had the time to dedicate to A&P I that they thought they would. On the other hand, Knight and Smith (2010) suggested that previous coursework in the sciences may have led to those in the Science group to develop a better mental framework, encouraging the use of deeper learning. They further proposed that both study habit differences (time and strategy) may reflect different attitudes towards the class. However, at our institution, students in the Science group are actually less likely to have previous A&P coursework at the college level compared to their counterparts in the Kinesiology and Miscellaneous groups.

Other studies predicted that study time along with career goals, not learning preferences, are associated with better performance among a diverse group of students in undergraduate A&P (Breckler et al. 2009; Farkas et al. 2016). For instance, pre-medical students may be more highly motivated as they are seeking admission to competitive programs. Nearly double the percentage of students in the Science group chose "Health Professions at the Doctorate Level" as a career goal in this study as compared to the Kinesiology and Miscellaneous groups.

Sturges and coauthors (2016) explored the relationship between student motivation, grade expectation, and academic performance in combined human A&P classes. They found that students were more likely to be extrinsically motivated, indicating a strong preference for rewards or avoidance of punishment and guilt as main drivers to succeed. Their results indicated that students with higher GPAs, who studied for longer periods of time and self-reported to be more motivated to succeed, did better academically in this class.

One may predict an increased likelihood of academic success for students in our Science group based on a review of the existing literature. The Science group had a greater percentage of multimodal learners (Goldman and Hudson 1973; Hu et al. 2017), were less likely to change study habits (Cook 1991; Husmann et al. 2015; Ward and Walker 2008), may have been more highly motivated given their career choice (Breckler et al. 2009; Farkas et al. 2016), and were perhaps more prepared given previous or concurrent coursework in the sciences (Knight and Smith 2010). However, the percentage of students

withdrawing from the course or receiving a grade of D or F was not statistically different between the Kinesiology, Science, or Miscellaneous groups.

#### Perceived Difficulty of the Course

In terms of perceived difficulty, the most common response on both the initial and final surveys among all academic groups was 8/10 and the majority of students stated on the final survey that they felt the class was harder than they thought it would be. A 2007 study by Michael sought to better understand this difficulty by asking faculty for their perceptions of why students struggle to learn physiology. Sturges and Maurer (2013) investigated allied health students' perceptions of what makes the combined undergraduate human A&P class so difficult. Their findings addressed the issue of student ownership as it was evident that students acknowledged their contribution to making this class difficult, even more so than the responsibility they placed on their instructors.

A 2019 study by Slominski and coworkers replicated these studies by collecting survey responses from 466 students at 4 different institutions and from 17 instructors at 15 different institutions. Students in their study attributed the difficulty of human A&P to the nature of the discipline, as opposed to the way physiology was taught or the way students approached learning it. Faculty, like those in the original study by Michael, attributed physiology's difficulty to factors inherent to the discipline itself. Despite recognizing A&P to be a difficult course, Sturges et al. noted that almost 66% of students in their 2016 study overestimated their final grade, with 29% overestimating it by two to four letter grades.

#### Student Success Rates

We did not find a statistical correlation with success in our A&P I course related to academic group. This differs from Gwazdauskas et al. (2014) who found that biology majors (part of our Science group) did better than other majors. More strongly correlated with success in our A&P I course was class standing with freshmen and sophomores accounting for nearly 81% of all D's, F's and withdrawals from the course.

As noted in previous studies, freshman- and sophomore-level students often have a more novice-like approach to learning new material, relying on extensive memorization and using less effective and/or alternative reasoning pathways in response to contextual surface features (Chi et al. 1981; Slominski et al. 2019). These tendencies, along with limited experience learning in undergraduate science classrooms, could lead a student to attribute physiology's difficulty to teaching practices or studying approaches, as opposed to the discipline itself (Slominski et al. 2019). While it is not possible to identify the specific factors responsible for the higher DWF rate of freshman students in our study, the factors responsible for lower scores in other studies may be involved with our group as well.

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## Conclusion

There appeared to be no statistical difference in the successful completion of this human anatomy and physiology course between academic groups. Learning style preferences did not appear to vary between the groupings by major although the Science group was more likely to have multimodal learners. The Science group was also more likely than the Kinesiology or Miscellaneous groups to maintain consistent study habits but did not devote as much study time to A&P I as they had predicted compared to the other academic groups. One interesting note is that there were significantly fewer students in the Science group compared to the other two groups who reported taking a previous A&P course at the college level. We do not know if the students in the Kinesiology and Miscellaneous groups, who did report taking a prior college-level A&P course, were repeating the same course or had taken another course. However, this prior course may have been advantageous for some students in these two groups and increased their successful completion of the course.

All academic groups perceived this A&P I course to be equally difficult. One may think that career choice could lead to greater motivation to succeed in A&P among those seeking admission to programs such as medicine or dentistry, of which the Science group contained a greater percentage. Class standing did correlate with student success in this A&P I course; however, students were not surveyed about their career choices, perceptions of learning style preferences, or study habits based on their class standing so it was not possible for us to make any conclusions regarding this data. Investigations into student perceptions with regard to class standing may be worthy of further investigation given its potential impact on program design.

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## APPENDIX: Initial and Final Surveys Human Anatomy and Physiology

### Research Study Initial Questionnaire

We are interested in learning your initial perceptions about the Human Anatomy and Physiology class and how your study habits and attitudes towards studying in general will influence your approach to studying for the course. With this in mind, we are asking you to complete the following questionnaire. Your participation is voluntary and will have no influence on class grades as all responses will be anonymous and class information will be kept confidential. If you choose to participate, please answer all of the following questions honestly. Do not put your name anywhere on this survey. If you have any questions about this questionnaire, please ask your instructor.

**Instructions for Descriptive Questions:** Please put an "X" by the correct option for each question.

1. What is your current academic major?

Athletic Training

Biology

Chemistry

Exercise and Sport Science

Health Science

Transfer for Health Profession (Pre-Dental Hygiene; Pre-Nursing; Pre-Occupational Therapy)

Other

2. What is your ultimate career goal?

Athletic Trainer

Health Profession at the Bachelor's (B.S. or B.A.) level (i.e. B.S. in Dental Hygiene, B.S. in Nursing, etc.)

Health Profession at the Master's level (i.e. Occupational Therapist, Physician's Assistant, etc.)

Health Profession at the Doctorate level (i.e. Chiropractor, Doctor of Osteopathic Medicine, Medical Doctor, Nurse Practitioner, Optometrist, Pharmacist, Physical Therapist, Veterinarian, etc.)

Personal Trainer

Research or Academic position that requires a Master's level degree (M.S.)

Research or Academic position that requires a Doctorate's level degree (Ph.D.)

Other

3. Have you taken a previous Anatomy and Physiology course at the college level?

Yes

No

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**Instructions for Preference Questions:** Please answer the questions as honestly as you can and choose the most appropriate answer to each question. Do not spend a long time on each question as your first reaction is probably your best answer. Please put an "X" by the best answer for each question.

1. Which method of learning do you think *best* describes your learning style?

\_\_\_\_\_ Visual/Verbal Learner - Learn best by reading written material, such as a textbook or notes, and looking at diagrams, illustrations, and visual multimedia presentations

\_\_\_\_\_ Visual/Nonverbal Learner - Learn best by looking at diagrams, illustrations, and visual multimedia presentations *without* text

\_\_\_\_\_ Auditory/Verbal Learner - Learn best by listening to lectures or presentations and discussing material with a group as well as reading text

\_\_\_\_\_ Tactile/Kinesthetic Learner - Learn best by physically manipulating three-dimensional items, such as models or specimens

2. At this point, do you plan to use the same study techniques that you have used for other college classes for the Human Anatomy and Physiology class?

\_\_\_\_\_ Yes

\_\_\_\_\_ No

3. Compared to other college course that you have already taken, how much time do you plan to study for the Human Anatomy and Physiology course?

\_\_\_\_\_ More than other courses

\_\_\_\_\_ Same as other courses

\_\_\_\_\_ Less than other courses

4. On a scale of 1-10, with 1 being very easy and 10 being the most difficult, how difficult do you think this Human Anatomy and Physiology class will be? (Circle the correct number below.)

1    2    3    4    5    6    7    8    9    10

**Thank you for your participation!**

**Drs. Keller and Hughes**

## Human Anatomy and Physiology Research Study Final Questionnaire

Now that you have almost completed the Human Anatomy and Physiology class, we are interested in learning whether your initial perceptions regarding your approach to studying for the course have changed. We are asking you to complete a final questionnaire. As before, your participation is voluntary and will have no influence on class grades as all responses will be anonymous and class information will be kept confidential. If you choose to participate, please answer all of the following questions honestly. Do not put your name anywhere on this survey. *If you have any questions about this questionnaire, please ask your instructor.*

**Instructions for Descriptive Questions:** Please put an "X" by the correct option for each question.

1. What is your current academic major? (If you changed your major during the semester, please put an "X" on the first line **in addition** to an "X" by your current major.)

- Changed major during the semester
- Athletic Training
- Biology
- Chemistry
- Exercise and Sport Science
- Health Science
- Transfer for Health Profession (Pre-Dental Hygiene; Pre-Nursing; Pre-Occupational Therapy)
- Other

2. What is your ultimate career goal? (If your career goal changed during the semester, please put an "X" on the first line **in addition** to an "X" by your current career goal.)

- Changed career goal during the semester
- Athletic Trainer
- Health Profession at the Bachelor's (B.S. or B.A.) level (i.e. B.S. in Dental Hygiene, B.S. in Nursing, etc.)
- Health Profession at the Master's level (i.e. Occupational Therapist, Physician's Assistant, etc.)
- Health Profession at the Doctorate level (i.e. Chiropractor, Doctor of Osteopathic Medicine, Medical Doctor, Nurse Practitioner, Optometrist, Pharmacist, Physical Therapist, Veterinarian, etc.)
- Personal Trainer
- Research or Academic position that requires a Master's level degree (M.S.)
- Research or Academic position that requires a Doctorate's level degree (Ph.D.)
- Other

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**Instructions for Preference Questions:** As before, please answer the questions as honestly as you can and choose the most appropriate answer to each question. Do not spend a long time on each question as your first reaction is probably your best answer. Please put an "X" by the best answer for each question.

1. Which method of learning do you think *best* describes your learning style? (If you now think that your learning style is different from what you initially selected, put an "X" on the first line **in addition** to your current choice.)

\_\_\_\_\_ I believe I have a different learning style than I selected on the initial questionnaire

\_\_\_\_\_ Visual/Verbal Learner - Learn best by reading written material, such as a textbook or notes, and looking at diagrams, illustrations, and visual multimedia presentations

\_\_\_\_\_ Visual/Nonverbal Learner - Learn best by looking at diagrams, illustrations, and visual multimedia presentations *without* text

\_\_\_\_\_ Auditory/Verbal Learner - Learn best by listening to lectures or presentations and discussing material with a group as well as reading text

\_\_\_\_\_ Tactile/Kinesthetic Learner - Learn best by physically manipulating three-dimensional items, such as models or specimens

2. Did you ultimately use the same study techniques that you used for other college classes for the Human Anatomy and Physiology class?

\_\_\_\_\_ Yes

\_\_\_\_\_ No

3. Compared to other college courses that you have already completed, how much time did you actually study for the Human Anatomy and Physiology course?

\_\_\_\_\_ More than other courses

\_\_\_\_\_ Same as other courses

\_\_\_\_\_ Less than other courses

4. On a scale of 1-10, with 1 being very easy and 10 being the most difficult, how difficult was this Human Anatomy and Physiology class? (Circle the correct number below.) (If you have changed your opinion on this question, put an "X" on the first line **in addition** to circling your current choice. Also, indicate whether the class was easier than you thought it would be or harder than you thought it would be.)

1    2    3    4    5    6    7    8    9    10

\_\_\_\_\_ I have changed my opinion on this question

\_\_\_\_\_ The class was easier than I thought it would be

\_\_\_\_\_ The class was harder than I thought it would be

**Thank you for your participation!**

**Drs. Keller and Hughes**



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