Undergraduate Student Course Perceptions in Response to Pedagogically Different Approaches in Introductory Anatomy and Physiology

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Abstract

Our institution underwent a curricular revision to change the course approach for introductory anatomy and physiology courses from separate, discipline-specific human anatomy and human physiology courses to an integrated A&P I and A&P II course approach. Through a mixed-methods exploratory study, this research sought to determine undergraduate student perceptions of anatomy through this curricular revision. Data was collected through word associations, open-ended surveys, and course evaluation data. Our results indicate that undergraduate student perceptions of anatomy changed between the first course and the second course in the sequence, rather than between course approaches. Students in both course approaches reported similar interests, confusions, and difficulties related to anatomy education, and an awareness of the explicit and implicit curriculum was evident in student responses. However, some specific evaluation prompts exhibited a significant difference between course approaches. Results from this perception study can guide practitioners to consider the curricular context and unique challenges of anatomy and physiology students in meeting the expectations of the health care field. https://doi.org/10.21692/haps.2021.008

Key words: undergraduate perceptions, anatomy education, anatomy and physiology, course approach, curriculum

Introduction

"A student's perception of the learning context is an integral part of his or her experience of learning" (Ramsden, 1997, p.198).

Introductory human anatomy and physiology are large enrollment gateway courses required for continuation into a health care field (Fournier et al. 2017). These classes enroll students from various majors and are perceived to be difficult, content-heavy course sequences that are anxiety-provoking with high failure and withdrawal rates (Bergman et al 2013; Craft et al. 2013; Dobson and Linderholm 2015; Friedel and Treagust 2005; McKee 2002; Sturges and Mauner 2013; Sturges et al. 2016). Given that these courses are major requirements for a variety of allied health programs, such as nursing, pharmacy, and kinesiology, investigating the best way to maximize learning through course instruction and curricular components is a unique challenge that will have important consequences.

Though there is no standard approach to how undergraduate anatomy and physiology are instructed (Montayre and Sparks 2017), they are typically taught as a lecture with a laboratory component and either as an integrated two-semester series of anatomy and physiology (A&P I and A&P II) or approached as separate discipline-specific courses where human anatomy is followed by human physiology. The variation in the degree to which physiology is integrated into introductory anatomy curricula in the United States reveals a lack of consensus on the best pedagogical approach (Estai and Bunt 2016). Much of the available research on the effects of curricular integration within anatomy education has been conducted in the context of medical schools. There is an absence of research focused on the academic and affective impacts of integration, defined here as the combination of anatomy and physiology, at the undergraduate level.

Student course perceptions and the different ideas they have regarding learning are critical components of successful academic experiences (Trigwell and Prosser 1991). How students view the learning process is based on their perceptions of the course (Entwistle 1991) and is connected to motivation (Eagleton 2015; Nilsson and Stromberg 2008), interest, and a willingness to overcome difficulties. Several studies have shown that learning and academic performance increase when students have positive perceptions of the learning environment (Anderton et al. 2016; Emanuel and Potter 1992; Ferreira and Santoso 2008; Lombardi et al. 2014; Lucas 2001; Rizzolo et al. 2010).

Understanding student perceptions related to course approach is an important first step as the curriculum influences the student's educational experience and may potentially impact their chosen profession (Peterson et al. 2014). Eisner (1994) defines explicit and implicit types of curricula. Explicit curriculum is publicly available in the form of formal learning outcomes, goals, and objectives that are

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stated within course materials, and consists of intentional content that can be assessed as part of a course grade. Implicit curriculum, on the other hand, conveys informal and unofficial affective information, such as assumptions, values, expectations, perspectives, biases, attitudes, beliefs, and acceptable or unacceptable behaviors, which manifest as the culture of the learning environment. The implicit curriculum is often thought of as the "hidden curriculum" because it is not usually acknowledged or examined, but rather it encompasses the intentional and unintentional messages communicated to students through interactions within the learning environment, ranging from teaching strategies to institutional structures.

A large, public research institution in the northeast US underwent a curricular revision in fall 2018 to change their course approach from discipline-specific to an integrated A&P I and A&P II course sequence. The assumption underlying this change was the belief that providing students with physiological contexts while learning anatomy would allow for a deeper understanding of structure and function. This curricular change presented an opportunity to explore gaps in the literature that examine different elements of the integration process more deeply. Previous perception studies have been done in these foundational courses, however, research involving undergraduate perceptions of anatomy education from different pedagogical methodologies is lacking. This study fills the gap in the literature by examining student perceptions of anatomy surrounding a change in course approach from discipline-specific, human anatomy followed by human physiology, to an integrated, A&P I and A&P II, course sequence.

Methodology

Participants and Sampling

The study population consisted of a convenience sample of undergraduate students in large-enrollment, introductory human anatomy, human physiology, human A&P I, and human A&P II courses and their associated laboratories at a large doctoral-granting institution in the northeastern US. Two course approaches were examined: 1) a separate discipline-specific sequence consisting of introductory human anatomy followed by introductory human physiology; and 2) an integrated sequence of A&P I followed by A&P II. The discipline-specific course approach covered all major anatomical structures within each organ system in the first semester, followed by a physiological examination of the organ systems in the second semester. Integrated A&P I covered introductory terminology, cytology, histology, and the anatomy and physiology of the following organ systems: integumentary, skeletal, muscular, and nervous. A&P II covered the anatomy and physiology of sensory, endocrine, lymphatic, immune, circulatory, respiratory, urinary, digestive, and reproductive systems. The courses do not have any prerequisites, are required for all health care majors (mainly nursing, kinesiology, and pharmacy), and were administered to multiple sections, each containing 150+ students, via three hours of interrupted (using clicker questions) lectures per week with an associated three-hour weekly laboratory.

Institutional Review Board (IRB) approval was obtained for this study, (IRBNet #1007697, HU1617-124), participation was voluntary, and students were not incentivized. Participants were predominantly female (71.61%), White (73.69%), college-aged (mean=19.14 years, SD=1.87 years), and not of low socioeconomic status (SES) as determined by Pell Grant eligibility (not Pell eligible=76.37%). Grades in the class ranged from A to F and were fairly evenly distributed (skew = -0.71, kurtosis = 0.38) with most students receiving a B and within the range of A to C. Demographic variables for consented students were comparable to the enrolled course population and similar between course approaches.

Data Collection

Data collection for this mixed-methods exploratory study occurred from spring 2017 through spring 2020. To be included in the analyses, a student had to be over 18 years of age and consent to participate in this study each semester. From spring 2017 to fall 2018, 1,030 (73%) students who had enrolled in the discipline-specific course sequence of introductory human anatomy followed by human physiology participated in the study (cohort 1). A change in course approach occurred in fall 2018 to an integrated A&P I and A&P II (cohort 2), and 1,429 (96%) A&P students consented to participate through spring 2020. The use of an "opt-out" consent form began in spring 2018 and is attributed to the increase in consent rates seen in subsequent semesters.

This research used an open-ended survey, a word association activity, and course evaluations to explore student perceptions at different time points as they progressed through the courses. A "welcome to class" survey was administered before the start of each course to gather perceptions on what students found interesting, confusing, and difficult about anatomy. Following Cassidy (2016), students were also asked to "List 10 words that you associate with anatomy". Data were collected at the start of each semester from both cohorts 1 and 2. To determine if perceptions changed based on course approach, comparisons between cohort 1 and 2 responses were examined. To determine if changes in perceptions occurred following the completion of human anatomy or an A&P I course, responses from the second course in the sequence, either human physiology or A&P II, were obtained.

To further assess student perceptions, course evaluations at the end of the semester asked students to rate statements related to the course and learning environment specific to two constructs-- "contribution to learning" and "course content" (Appendix A). Participation was voluntary, anonymous, and in addition to the institutional course evaluation. The global COVID-19 pandemic forced a

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transition to online learning during spring 2020; therefore, course evaluation data was not utilized that semester. The survey generated 792 (32%) student responses (352 human anatomy students and 440 A&P I students).

Data Analysis

Open-ended survey responses investigating what students found most interesting, confusing, and difficult about anatomy were qualitative coded using thematic descriptive coding (Braun and Clarke 2006) and underwent a quantitative content analysis (Bernard 2012) to determine and quantify the frequency of emergent themes. Generally, student responses consisted of a couple of sentences or a succinct phrase. Working with an undergraduate research assistant, responses were read in their entirety and an *a posteriori* codebook was developed reflecting emergent themes (Basit 2003). Student responses often contained more than one theme, such as "muscles and bones" (A&P II). Multiple codes were assigned in the order they occurred (primary, secondary, tertiary), and total response rates were generated. Responses were then separated by primary code per course and read again to ensure consistency within each theme; a percentage of agreement or an interrater reliability score of 93% was obtained. Any disagreements were debated until consensus was reached. Cohort 1 provided 815 coded responses from 763 human anatomy students and 1,009 coded responses from 960 human physiology students. Cohort 2 provided 1,172 coded responses from 1,121 A&P I students and 1,047 coded responses from 918 A&P II students.

Thematic analysis was applied to word lists generated by the word association activity and coded for valence (positive, negative, neutral/ambiguous) of frequently used words. Because some words associated with anatomy, such as "commitment", "hard", and "challenging", were impossible to accurately code without context, they were coded as "neutral/ambiguous".

Course evaluations at the end of the semester asked students to rate statements related to the course and learning environment. Question items focusing on instructor quality were removed per the request of faculty members, leaving two constructs - one representing student's personal "contributions to learning" and the other representing perceptions of the "course content". The "contributions to learning" question items asked students to rate seven statements related to their participation, including the "level of effort put into the course", "skill/knowledge required to complete the course", and "attendance is required to be successful in this course". Ratings were scored from 1 (poor) to 5 (excellent). The "course content" question items, designed to assess student perceptions of course content, asked students to rate eight statements for agreement on a Likert scale from 1 (strongly disagree) to 5 (strongly agree). Example items include "learning objectives were clear"," "the lab complemented my understanding of the lectures", and "I would prefer to learn anatomy and physiology at the same time". Among those who responded, there were no missing responses. Each item was examined for univariate skewness and kurtosis and was demonstrated appropriate for the analysis per recommendations by Harlow (2014: largest skew = -1.67; largest kurtosis = 3.59).

Factor analysis was used on course evaluation responses to assess internal structure and consistency. Because the sample size of the course evaluation data was sufficiently large, question items were cross validated using exploratory and confirmatory methods. The data were randomly split, with 237 cases (30%) used for exploratory analysis and 555 cases (70%) used for confirmatory analysis. Before random selection, the data were stratified by course approach (discipline-specific human anatomy versus integrated A&P) to ensure that both groups would be equally and proportionally represented in the analysis.

For the exploratory factor analysis, all 15 variables were included in the analysis. It was hypothesized that there would be two factors identifiable from the data, corresponding to the "contributions to learning" and "course content" constructs. This allowed for an evaluation of the internal structure of the course evaluation items and for the identification of question items that should be removed from the analysis. Additionally, internal consistency was estimated by McDonald's coefficient omega (1999). This represents the ratio of common factor variance to total variance within the construct (Furr 2017). Within exploratory factor analysis, this can be estimated with an oblique factor rotation and a Schmid Leiman transformation to account for internal structure and correlation to a general factor (student academic achievement) across all items.

Based on the results of the exploratory analysis, the confirmatory factor analysis was performed using maximum likelihood model estimation. Clustered intercepts were included by class section. Additionally, multiple sample analyses were performed to compare the internal structure between the two course approaches. This was done by estimating models for each course section separately, then systematically increasing constraints requiring increasingly strict model similarities, and assessing the impact on model fit. This allowed for a direct comparison of response structure between course approaches, and the extent to which the two groups can be considered similar. Coefficient omega internal consistency can be calculated as the ratio of factor loading variance to the total variance, loading, and error (Furr 2017).

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Lastly, once the subsets of invariant question items that can be directly compared between the two course approaches were established, the means between groups were compared. This was accomplished using generalized linear mixed modeling. The fixed effect of interest was the difference between course approaches. Additionally, random intercepts were included by class section to adjust for the known structure of the data. A brief *a priori* power analysis was performed, suggesting that the design was powered to detect even a small effect (power = 0.80, alpha = 0.05, Cohen's d = 0.20).

Results

Word Association

Cohorts 1 and 2 responded with 25,309 words associated with anatomy. Four themes were evident in the list of words: 1) "structure"; 2) "vocabulary", which was further sub-coded into "physiology term/concept" and "clinical/career"; 3) "descriptive", which was sub-coded as "descriptive ambiguous", "descriptive positive", and "descriptive negative"; and 4) "unknown/other". A summary of the coding frame and themes is provided in Table 1.

Theme	Explanation of Use and sample responses
Structure	Pertains to any specific anatomical structure. "sternum", "cerebrum", "liver"
Vocabulary	Vocabulary theme applied to explanatory words. "abduction", "insertion", "posterior".
Physiology term/concept	Vocabulary words related to function. "contraction", "excretion", "homeostasis"
Clinical/career	Vocabulary words associated with the health care field. "medicine", "nursing", "helping"
Descriptive	
Ambiguous	Words that could not be determined to be positive or negative without context. "complicated", "detailed", "effort"
Negative	Words that had negative connotations. "stressful", "tedious", "painful".
Positive	Words that had positive connotations. "fun", "happiness", "motivating"
Unknown/other	Words that did not fit into any of the other themes, such as "library", "analysis" and "blueprint" as well as words related to the course such as "exams", "grade", or "lab".

Table 1. *Thematic coding frame for words associated with anatomy with textual examples.*

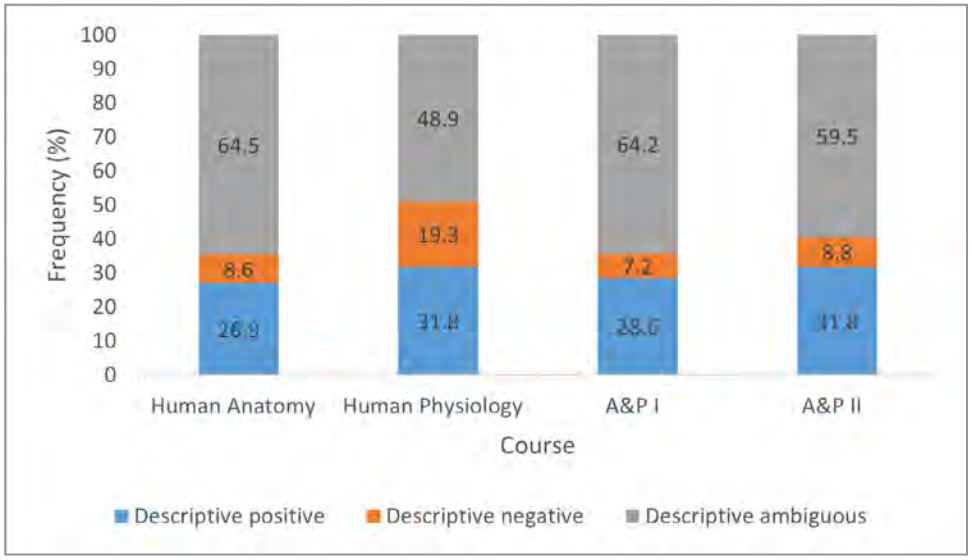

Figure 1. *Undergraduate anatomy word association "descriptive" code frequencies for positive, negative, and neutral terms, between different course approaches, discipline-specific (human anatomy, human physiology), and integrated (A&P I, A&P II).*

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Cohort 1 human anatomy students listed "vocabulary" words (n=2,892, 43.3%) most often, followed by "structure" words (n=2,632, 39.36%). "Structure" (n=3,102, 43.3%) and "vocabulary" words (n=2,802, 39.1%) were also the most common terms associated with anatomy by human physiology students. Similar responses were obtained from cohort 2. A&P I students listed "vocabulary" words (n=3,084, 45.6%) most commonly, followed by "structure" words (n=2,319, 34.3%). For students enrolled in A&P II, "structure" words (n=1,856, 39.7%) were the most common with "vocabulary" words being second (n=1,807, 38.6%).

Since the aim of the word associations was to ascertain student perceptions of anatomy in different course approaches at different time points, descriptively coded words --either positive, negative, or neutral-- were isolated to determine student responses. Cohort 1 students associated 535 (8.0%) descriptive words with anatomy at the start and 695 (9.7%) at the end of human anatomy. Similarly, students in cohort 2 used 525 (7.8%) descriptive words at the start of A&P I and 513 (11.0%) at the end. A change in the response rates for descriptive terms between the start and end of the semester revealed a shift in anatomy perceptions following the completion of either human anatomy or A&P I (Figure 1).

Student Perceptions of What They Found Interesting, Confusing, and Difficult about Anatomy

"What do you find most interesting about anatomy?" Through open-ended surveys at the start of each semester, both cohorts were asked, "What do you find most interesting about anatomy?" Five themes emerged from the data: 1) "physiology", 2) "personal connection", 3) "anatomical parts", 4) "anatomical systems", and 5) "other". The coding framework, including examples of student responses, is provided in Table 2. Thematic code response rates for each cohort are presented in Table 3. The "anatomical systems" theme was sub-coded to reveal what specific systems students found interesting (Table 4). The sub-theme of "other system" included specifically named systems (such as endocrine, digestive, or reproductive), or general statements such as "I really enjoyed learning about the body systems" (A&P I).

Code	Description	Example
Physiology	Responses that highlighted physiological concepts or functions as an interesting aspect of anatomy.	"Understanding how each system works to maintain homeostasis in the body" "Learning about the functions of the body" "The way the body works together and how everything works as a unit"
Personal connection	Responses that related subject matter to understanding self/others.	"That this branch of science isn't just some facts. Anatomy is everyone. Everything that we learn in anatomy can be found in everyone" "That you can relate this topic to yourself" "It is interesting to find out how your own body works. You're able to see what's actually going on inside of you!"
Anatomical parts	Responses included general anatomical phases about the structures or parts of the body.	"I loved learning about the parts of the body" "The structures of the body" "Discovering the lesser known parts of the body"
Anatomical systems	Referenced specific anatomical systems or general statements about the systems of the body.	"I found the nervous system the most interesting" "Learning about all the different bones and bone markings of the human body" "The body and all its systems"
Other	Included answers that did not fit the other categories, aspects related to the course, and general statements that everything or nothing was interesting.	"dissections" "My professor" "Being able to recognize terms on medical shows"

Table 2. *Thematic codes, their description, and examples for what students found interesting about anatomy.*

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	Human Anatomy		Integrated A&P I	
Code Description	**Start**	**End**	**Start**	**End**
Physiology	47.0%	32.0%	49.2%	37.2%
Personal connection	16.3%	11.6%	11.0%	10.4%
Anatomical parts	12.1%	13.2%	16.4%	14.3%
Anatomical systems	16.7%	38.0%	15.2%	29.2%
Other	8.0%	5.3%	8.2%	8.8%

Table 3. *Thematic code response rates (%) for both cohorts to what they found most interesting about anatomy at the start (n=763) and end (n=960) of human anatomy or the start (n=1,121) and end (n=918) of an A&P I course.*

	Human Anatomy		Integrated A&P I	
Anatomical Systems	**Start**	**End**	**Start**	**End**
The muscular system	33.7%	26.3%	24.6%	41.1%
The skeletal system	32.0%	25.3%	27.0%	28.4%
The nervous system	13.4%	19.6%	21.0%	18.0%
The cardiovascular system	8.1%	13.7%	7.9%	1.8%
Other systems	12.8%	15.1%	19.4%	10.7%

Table 4. *The "anatomical systems" sub-theme response rates (%) for both cohorts to what specific systems they found most interesting about anatomy at the start (n=172) and end (n=438) of human anatomy or the start (n=252) and end (n=394) of an A&P I course. (n refers to the number of times the "anatomical system" theme was coded).*

"What do you find most confusing about anatomy?" Seven themes were coded from the response data to this question. The themes were: 1) "anatomical systems", 2) "terminology", 3) "amount of material", 4) "memorization", 5) "physiology", 6) "complexity and detail", and 7) "other". Descriptions of these themes, including examples of student responses, are provided in Table 5, and Table 6 contains thematic response rates from students before and after the completion of human anatomy and A&P I. Again, the theme "anatomical systems" was sub-coded to highlight the specific systems students found confusing (Table 7).

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Code	Description	Example
Anatomical systems	Referenced specific anatomical systems or general statements about the systems of the body.	"I had a hard time with the origins and insertions of muscles" "There are hundreds of bones to remember" "The brain is mad hard"
Terminology	Applied to answers that discussed the vocabulary and/or language associated with anatomy.	"Terminology because there is lots of vocabulary associated with anatomy" "The intricate names for body parts" "A lot of the names for completely different body parts are very similar and can sometimes get confusing"
Amount of material	Responses referenced the amount of information presented in the course.	"How much of it there is" "The most confusing thing about anatomy is the amount of information you have to remember" "It is a lot of material to learn in a short span of time"
Memorization	Responses related to the act of memorizing content.	"I think the most confusing part about anatomy will be that there are a lot of things to memorize" "Memorizing everything" "Sometimes the memorization of the anatomy can be confusing. I like to truly learn and understand rather than memorize, which is hard to do with anatomy."
Physiology	Responses that highlighted physiological concepts, processes, or functions.	"The specific processes" "Different processes that happen in the body and understanding all the concepts within those processes" "If I had to say anything, it would be keeping track of different processes and pathways."
Complexity and detail	Responses related to the complexity of the human body or its specific details.	"How complex the body is" "Anatomy is so intricate" "How detailed the material is"
Other	Included answers that did not fit the other categories, aspects related to the course, or generic answers.	"The body" "The anatomy" "Finding the proper way to study"

Table 5. *Thematic codes, their description, and examples for what students found confusing about anatomy.*

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	Human Anatomy		Integrated A&P	
Code Description	**Start**	**End**	**Start**	**End**
Anatomical Systems	27.3%	55.2%	23.9%	39.0%
Terminology	26.9%	11.0%	23.6%	12.5%
Amount of material	10.3%	8.4%	11.8%	12.3%
Memorization	10.8%	7.2%	10.3%	7.0%
Physiology	7.3%	6.0%	10.1%	14.2%
Complexity and details	5.0%	3.2%	6.8%	6.0%
Other	12.4%	10.0%	13.5%	9.1%

Table 6. *Thematically coded student response rates (%) at the start (n = 763) and end (n=960) of human anatomy and the start (n=1,121) and end (n=918) of A&P I, to the question, "What do you find most confusing about anatomy?"*

	Human Anatomy		Integrated A&P I	
Anatomical Systems	**Start**	**End**	**Start**	**End**
The muscular system	32.5%	39.9%	27.4%	27.8%
The skeletal system	25.6%	11.6%	25.4%	13.6%
The nervous system	23.5%	40.7%	19.5%	51.8%
The cardiovascular system	9.8%	6.4%	8.8%	0.4%
Cells and tissues	8.6%	1.5%	18.9%	6.4%

Table 7. *The "anatomical systems" sub-theme response rates (%) for both cohorts to what specific systems they found most confusing about anatomy at the start (n=234) and end (n=622) of human anatomy or the start (n=354) and end (n=450) of an A&P I course. (n refers to the number of times the "anatomical system" theme was coded).*

"What do you find most difficult about anatomy?"
Regardless of course approach, as shown in Figure 2, students rated the difficulty of their course as high on a scale of 1 (not at all difficult) to 5 (very difficult) (human anatomy, M=3.98, SD=0.64; human physiology, M=3.92, SD=0.70; A&P I, M=3.82, SD=0.69; A&P II, M=3.89, SD=0.66). To determine what aspects students found difficult about anatomy, a quantitative content analysis was conducted on the open-ended survey question, "What do you find difficult about anatomy?" Seven themes emerged: 1) "amount of material", 2) "memorization", 3) "time/time management", 4) "terminology", 5) "the pace of course", 6) "course components", and 7) "other". The coding frame for what students in both cohorts found difficult about anatomy is presented in Table 8. Response rates per thematic code before and after completing human anatomy or an A&P I course are provided in Table 9. Chi-square analysis determined statistically significant differences in proportions between what human anatomy and A&P I students found difficult in the themes "amount of material", "memorization", "terminology", and "pace" over time (Table 9).

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Code	Description	Example
Amount of material	Responses referenced the amount of information presented in the course.	"The copious amount of information" "The sheer amount of content" "An overwhelming amount of work"
Memorization	Responses related to the act of memorizing content.	"Although I tried my best to avoid it, times came where I had to memorize things. I struggle with memory a lot of times so this made learning the content difficult at times" "Memorizing everything that needs to be memorized" "I had a hard time memorizing everything"
Time/Time management	Any answers related to time or the student's ability to manage their time with outside commitments.	"This is a time consuming course and I need to find the time to put into it" "Balancing organic chemistry, other classes, and a job in my schedule while making sure I am prepared" "Me procrastinating"
Terminology	Applied to answers that discussed the vocabulary and/or language associated with anatomy.	"The long words and extensive vocabulary" "Most of the parts we had to learn were practically in a different language, making pronouncing and spelling very difficult" "Just some of the vocabulary for the processes would get me tricked up because if you could not figure out what the term meant then there was no way to answer the questions" "The vocab since English is my second language"
The pace of the course	Responses related to how quickly content was covered in the course.	"Keeping up with the pace of the lectures" "I anticipate a fast-paced class will make learning this content difficult for me" "I think the fast pace. I'm still learning how to keep up to pace with the lectures and actually understanding the concept and getting it before we move onto the next unit"
Course components	Responses involving the learning environment, course design, the professor, or other course-related obstacles.	"The teaching methods of the professor" "I took the course at 8 am and I could not get out of bed for the life of me" "Lab wasn't always lined up [with lecture], which was incredibly frustrating"
Other	Included answers that did not fit the other categories, such as generic answers, physiology, personal reasons, study approaches, and nothing/everything being difficult.	"It was not difficult; I thoroughly enjoyed the class" "My disinterest in the subject" "If I don't participate" "Pathways" "My attitude" "I have the attention span of a squirrel"

Table 8. *Thematic codes, their description, and examples for what students enrolled in discipline-specific and integrated human anatomy and physiology classes found difficult about anatomy.*

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	Human Anatomy		Integrated A&P I	
Code Description	**Start**	**End**	**Start**	**End**
Amount of material	25.4%	39.7%	29.9%*	37.6%
Memorization	17.5%	10.8%	16.4%	7.7%*
Time/Time management	16.7%	11.3%	14.7%	12.2%
Terminology	15.4%	5.1%	10.8%*	4.6%
Other	13.1%	13.3%	13.7%	13.7%
Pace	8.6%	15.9%	10.7%	19.9%*
Learning environment	3.3%	3.9%	3.9%	4.3%

*significant difference ($p<.05$) between difficult themes for students in human anatomy and A&P I at the start or end of the semester

Table 9. *Thematic codes for student responses to the question "What do you find most difficult about anatomy?" listed response rate (%) at the start (n=763) and end (960) of human anatomy and the start (n=1,121) and end (n=918) of A&P I.*

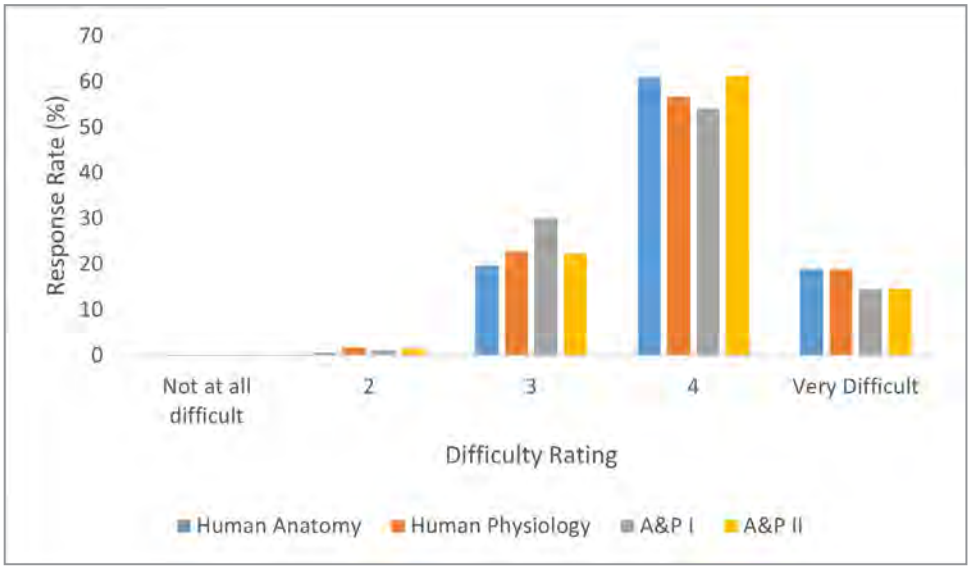

Figure 2. *Student difficulty rating (1, not at all difficult to 5, very difficult) at the start of the semester for human anatomy (n=763), human physiology (n=960), A&P I (n=1,121), and A&P II (n=918).*

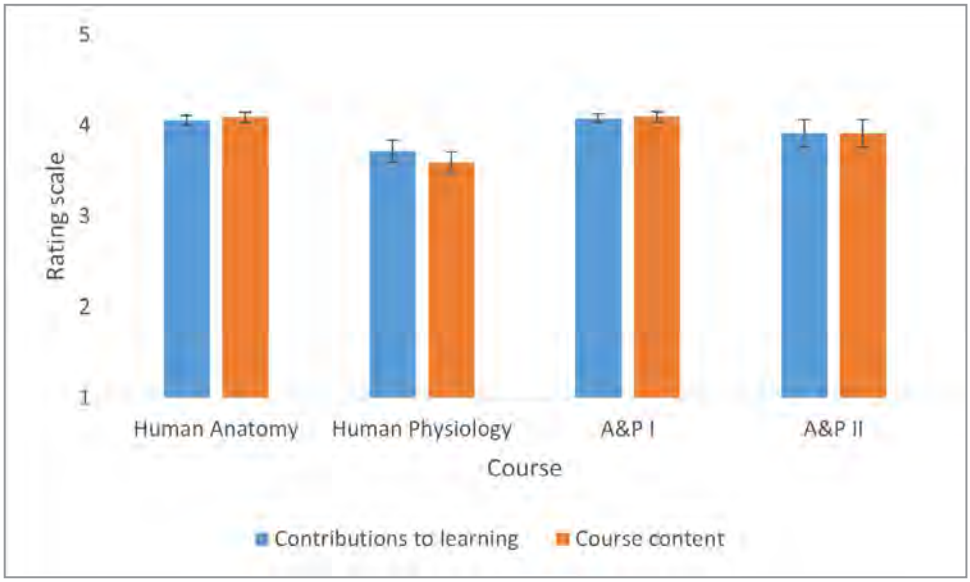

Figure 3. *Estimated means and 95 percent confidence intervals for two course evaluation subscales, "contribution to learning" and "course content" per course approach, separate discipline-specific human anatomy and human physiology, and integrated A&P I and A&P II.*

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A. Contribution to Learning

Statement	Percentage of responses in a scale of agreement, Human Anatomy, A&P I				
	Excellent	Very Good	Satisfactory	Fair	Poor
Level of effort you put into the course	46.7, 40.9	39.3, 41.4	10.5, 15.5	3.1, 2.3	0.6, 0.0
Level of skill and knowledge at the start of the course	5.7, 3.9	11.1, 12.3	33.1, 34.6	28.5, 28.6	21.7, 20.7
Level of skill and knowledge at the end of the course	39.0, 40.5	48.4, 45.7	10.8, 12.3	1.4, 1.6	0.3, 0.0
Level of skill and knowledge required to complete the course	35.6, 36.1	48.7, 47.5	14.5, 13.0	1.1, 3.0	0.0, 0.5
In this course, I learned a great deal	65.2, 65.9	25.1, 25.7	8.8, 6.6	0.9, 1.1	0.0, 0.7
The course developed my ability to think critically about the subject*	46.4, 56.6	35.9, 27.7	15.1, 11.8	2.3, 3.4	0.3, 0.5
Attendance is required to be successful in this course*	58.1, 66.1	24.2, 22.7	13.4, 8.0	2.9, 2.7	1.4, 0.7
B. Course Content					
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Learning objectives were clear	58.1, 58.4	33.9, 36.1	6.0, 4.3	1.1, 0.7	0.9, 0.5
Course content was organized and well planned	59.3, 60.9	32.8, 31.4	6.6, 6.1	1.1, 0.7	0.3, 0.9
Course workload was appropriate	42.7, 38.6	37.6, 38.4	14.0, 13.2	5.4, 6.8	0.3, 3.0
Course organized to allow all students to participate fully	50.4, 52.1	35.9, 32.5	10.8, 12.1	2.0, 2.7	0.9, 0.7
The lab complemented my understanding of the lectures*	56.1, 41.1	31.9, 35.5	8.0, 15.0	3.1, 6.1	0.9, 2.3
Course materials were affordable	19.7, 16.8	31.1, 27.5	25.4, 30.0	14.3, 18.6	9.7, 7.1
Being able to pay for the course materials is stressful*	35.9, 29.3	32.2, 31.1	20.8, 23.2	8.3, 13.2	2.9, 3.2
I would prefer to learn anatomy and physiology at the same time.*	30.8, 50.5	19.1, 21.4	22.5, 8.4	13.1, 11.1	14.5, 8.6
	Too fast	Slightly fast	About right	Slightly slow	Too slow
The pace at which material was covered was ……..	14.5, 17.8	63.0, 68.3	22.5, 13.9	0.0, 0.0	0.0, 0.0

*p<0.05

Table 10. *End of semester course evaluation statements and the corresponding percentage of responses for human anatomy and A&P I.*

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Course Evaluation Results

Factor analysis revealed two constructs, "contribution to learning" and "course content", in the course evaluation data. Appendix B provides an overview of factor invariance. To compare cohort perceptions of anatomy, the first course in each sequence, human anatomy and A&P I, were the foci. The mean difference (Figure 3) in "contributions to learning" was very small, only 0.02 on a five-point scale (Cohen's d = 0.04). This was not a significant difference (t (785) = -0.44, p = .6620). The difference in "course content" was even smaller, with a difference of only 0.01 (Cohen's d = 0.01). This was also not a significant difference (t (785) = -0.16, p = .8726).

However, individual question items between cohorts determined a statistically significant difference in perceptions of anatomy (Table 10). Human anatomy students responded significantly more favorably for two question items, "The lab complemented my understandings of lectures" (t(785)=4.96, p<.001, Cohen's d =0.35), and "Being able to pay for the course materials is stressful" (t(785)=2.37, p=.018, d=0.18). A&P I students had a significantly higher response rate for three question items, "The course developed my ability to think critically about the subject" (t(785)=-2.16, p=.030, d=0.13), "Attendance is required to be successful in this course" (t(785)=-2.88, p=.004, d=0.19), and "I would prefer to learn anatomy and physiology at the same time" (t(785)=-5.18, p<.001, d=0.41).

Discussion

The goal of this study was to determine undergraduate students' perceptions of anatomy during a curricular revision from a discipline-specific to an integrated A&P course approach. The discipline-specific course approach (cohort 1) contained the same content and expectations as the integrated A&P (cohort 2) sequence. Anatomy content was consistent and delivered via interrupted lectures in both approaches, yet exciting findings emerged between cohorts. Cohort 2 found the course developed their ability to think critically about anatomy more so than students enrolled in discipline-specific human anatomy. Previous research noted allied health majors were best served through the development of critical thinking skills (Johnston and McAllister 2008; Tanner 2003) and introducing physiological concepts when learning anatomy provided the context to connect content with purposeful learning (Anstey 2017). Research involving biology undergraduates further supported contextual learning as a method to increase critical thinking skills (Bustami et al. 2018).

Course-specific research exists, yet studies comparing course approaches at the undergraduate level between discipline-specific and integrated A&P is lacking. Johnston and McAllister (2008) found that 97% of A&P students agreed with the statement "the laboratory helped them understand the material presented in lectures". Conversely, Montayre and Sparks (2017) concluded that A&P students found the lab important but an unnecessary component to pass the course. Concerning the laboratory, this study found human anatomy students felt "the lab complemented [their] understandings of lectures" more so than A&P students. This might be due to the discipline-specific nature of human anatomy, where the lab is solely focused on structures and the anatomical content directly reinforces lecture material.

Students are likely to view learning anatomy as memorization intensive when course design assesses students on large lists of structures and labeled diagrams (Bandyopadhyay and Biswas 2017; Bergman et al. 2013; Choudhury and Freemont 2017; Miller et al. 2002; Wilhelmsson et al. 2010). The perception that anatomy is a topic best approached through memorization was pervasive in both cohorts, yet even with the same required list of structures, the integration of physiology revealed a significant difference in the perception of "memorization". Cohort 2 reported "memorization" as a difficult aspect of the course significantly less than cohort 1 at the end of the first semester in the sequence (human anatomy or A&P I). Additionally, cohort 2 felt more strongly that "attendance was a requirement for course success". Cohort 1's view on attendance could be connected to their perception that "memorization" is a requirement for learning anatomy (not critical thinking) and therefore does not require class attendance to be successful.

Students likely seek to understand anatomy content and simply see memorization as a path to that outcome (Wilhelmsson et al. 2010). Mitchell and Batty (2009) pointed out that students "must emerge with a core understanding of anatomy, but not an encyclopedic knowledge of the human form" (p. 118), and a balance between memorization, understanding, and visualization leads to a successful anatomy learner (Pandey and Zimitat 2007). By the end of the semester, students recognized that learning anatomy was more about understanding than rote memorization (Marton et al. 2005). Consistent with these findings, the context of physiology further reduced the perception that learning anatomy consists of memorization (Bergman et al. 2013). As Wilhelmsson et al. (2010) pointed out, the medical student's perception of the importance of incorporating the context of physiology aided their ability to memorize massive amounts of anatomical structures, as the function "frames the structure into a surrounding functional unit" (p. 159).

Students are often influenced by both the explicit and implicit curriculum (Cassidy 2016). Both cohorts combined implicit and explicit curricular examples for what they found interesting, such as "The body itself. It's amazing how many bones are in our body, how the system work [sic] together and so on" (Human Anatomy), and "The

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human body is so complex and learning anatomy gives me a better understanding and appreciation for my own body" (Human Physiology). In these examples, the implicit curriculum is evident in students' amazement and fascination with the human body, whereas the explicit curriculum relates to specific anatomical content. Despite an emphasis on individual structures, many responses highlighted a holistic and interconnected way of thinking about anatomy, such as "Anatomy explains what every living being is made of, which is absolutely crazy and mind blowing!! It is the study of ourselves!" (A&P I).

Quantitative content analysis findings showed that initial interest in the implicit curriculum, such as student's "personal connection" to anatomy, decreased in favor of the explicit curriculum. This shift might be from students gaining anatomical knowledge, rather than a decrease in their interest in the implicit curriculum. The combination of the implicit and explicit curriculum can be leveraged to sustain and expand student's initial excitement and motivation for the subject by deliberately incorporating appreciation, delight, and wonder for the *amazing* human body.

Regardless of course approach or whether students responded before or after human anatomy or A&P I, the "amount of material" was perceived to have the greatest impact on course difficulty. This finding supports previous research that determined medical students perceived the amount of anatomy they needed to learn to be daunting (Smith and Mathias 2010; Mattick and Knight 2007). In agreement with the research presented here, Sturges and Maurer (2013) found undergraduate students reported A&P difficulties in three areas: 1) the discipline (subject and content), 2) the student (study habits, organization, and time management), and 3) teaching factors (grading style and course resources). Their qualitative analysis also concluded the "language of the class" led to A&P difficulty. Although the students expressed difficulty learning the language of anatomy, "terminology" was identified as a less important influence. Regardless of course approach, students often combined "the amount of material" with the "pace" of the course in statements such as, "I think that the speed of the course and the amount of information covered made it difficult" (A&P II), and, "The large amount of material that is covered in a short amount of time is the thing that makes this content the most difficult for me" (Human Anatomy).

Personal factors influencing course difficulty were also reported. These findings support Eagleton (2015) who found social and personal distractions, as well as those surrounding studying, student living conditions, and their financial concerns, were contributing factors to the perceived course difficulty of A&P. Cohort 1 students exhibited significantly more concern paying for course materials since they were required to purchase materials for each course separately, human anatomy *and* human physiology. Cohort 2, on the other hand, had the financial advantage of using the same course materials for the yearlong sequence.

Additionally, the top themes making anatomy difficult for both cohorts, "amount of material", "time/time management", "memorization", and the "pace" of the course, can be thought of as part of the implicit curriculum of first-year college students related to the ability to organize information, time management, effective study strategies, and persistence. As one student recognized: "If I fail to follow my study strategies or fail to show up to class weekly then I will begin to find the content difficult" (A&P I). With experience, perceived difficulties were overcome in statements like, "The amount of information was difficult, but once I figured out a rhythm of what I needed to do it was not as hard" (A&P II) and "Anatomy was difficult, but I did it!" (Human Physiology).

Student perceptions can be utilized to form recommendations for future course design improvements that minimize negative perceptions and increase learner satisfaction (Ferreira and Santosos 2008). Learner satisfaction can be obtained when students perceive the course as interesting and relevant (Eagleton 2015), resulting in more motivated students (Kember et al. 2000) with increased attention (Cassidy 2016), who perform better academically (Ferreira and Santosos 2008). Research on perceptions in A&P showed students who found the content relevant perceived it as important (Johnston and McAllister 2008) and were willing to put the work in to be successful. In this study, both cohorts found the explicit anatomy curriculum relatable because they like to learn "about the parts of the body in order to relate it to [their] daily life" (A&P II). If a program is interested in developing habits of mind (Costa and Kallick 2000) early in students through the implicit curriculum related to the human body, then student perceptions of the integrated A&P course sequence support this outcome due to the increased views on critical thinking and less memorization. However, if programs are more interested in discipline-focused instruction of anatomy for specific career programs, then physiological integration will not drastically change student perceptions.

Limitations

Although the data presented here support previous perception research, these findings should be interpreted within the context of several limitations. First, participants in this study were a convenience sample of classroom students from one institution, creating a selection bias, and reducing generalizability due to the homogeneity of the study population. The fact that most of the students were White females speaks to persistent underrepresentation of other groups, and perhaps to gendered career choices, such as nursing. Second, this study used self-reported data from students' responses

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to a survey tool, which could create a response bias. Third, because participation in the study was voluntary, data analysis was limited to those students who chose to respond, creating a sampling bias and any missing data would induce a response bias.

Fourth, this study involved classes taught by three different professors, one of whom was replaced in fall 2017, altering instructor consistency. Course professors met bi-monthly to plan and align course content to minimize confounding variables; however, teacher effect should be acknowledged as a limitation to this study. Fifth, this study was designed and conducted by one of the human anatomy/A&P I instructors, which could contribute to personal bias. Careful consideration was given to any ethical dilemmas or perceived participation coercion that may arise (IRB consent was obtained through a third party, student responses were sealed until after final grades were reported, and research assistants were utilized for interrater reliability). Also, perception research carries the limitation of personal bias from students as their career aspirations can influence what they perceive to be interesting (Chapman et al. 2013), and/or what challenges they are willing to work to overcome. Lastly, research was conducted in large lecture classes. It is unknown what role situational factors, such as the size of the class, the time of day it is offered, or the utilization of a more active learning model, would alter student perceptions.

Unfortunately, the qualitative data obtained through word associations and open-ended questions for what students found interesting, confusing, and difficult about anatomy did not provide clear evidence of a perceptional difference between course approaches as expected. The word association question might yield results that are more definitive if students were asked to rank positive and negative descriptive words to determine their perceptions. Also incorporating focus groups in a future study would capture more in-depth student perceptions by providing the opportunity for elaboration and allow researchers to ask clarifying follow-up questions. For example, it was unclear for the "muscles" response if students were confused by muscle physiology, the microanatomy of muscles, or from muscle identifications, their origins, insertions, or actions. Data could also be correlated to a student's major to determine if perceptions differ based on career aspirations. Additionally, future studies should include questions to investigate student perceptions of the null curriculum.

Conclusion

Research presented here provides students' perceptions from two course approach options for introductory anatomy and physiology. Understanding student perceptions can be used to improve course instruction and create more effective and engaging learning experiences. Perceptions of learning anatomy are largely driven by course expectations (Anderton et al. 2016), yet with consistent anatomical content and course expectations between cohorts, the addition of physiology created a learning environment more conducive to critical thinking. In addition to the benefit of contextual learning, results suggest an expansion of the implicit curriculum related to the amazement and delight of the human body would help create a learning environment that will maximize the efficiency in which students learn anatomy and physiology.

In keeping with Ravert and Evans (2007), this study does not imply the goal of quality course design is to "simply satisfy student preferences" (p. 325). Rather, it suggests that the curriculum could be tailored toward students' interests to increase attention and engagement. Deliberate focused instruction can be incorporated into the specific content areas students found confusing and difficult. Since anatomy and physiology are foundational courses for allied health majors, it is important to acknowledge the affective domain of learning (Hartley et al. 2018) and understand student perceptions, interests, confusions, and difficulties surrounding anatomy education.

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APPENDIX

Course Evaluation question items. "Contribution to learning" prompts were rated from 1 (representing "poor") to 5 (representing "excellent"). The "course content" question items asked students to rate eight statements for agreement on a Likert scale from 1 (representing "strongly disagree") to 5 (representing "strongly agree").

Subscale	Question prompt
Contribution to learning	Level of effort you put into the course
	Level of skill/knowledge at start of course
	Level of skill/knowledge at end of course
	Level of skill/knowledge required to complete the course
	In this course, I learned a great deal
	The course developed my ability to think critically about the subject
	Attendance is required to be successful in this course
Course content	Learning objectives were clear
	Course content was organized and well planned
	Course workload was appropriate
	Course organized to allow all students to participate fully
	The lab complemented my understanding of the lectures
	Course materials were affordable
	Being able to pay for the course materials is stressful
	I would prefer to learn anatomy and physiology at the same time.

Factor invariance test results

Model	X^2	DF	CFI	RMSEA	90% CI LL	90% CI UL	SRMR
Configural	291.99	152	0.92	0.068	0.058	0.079	0.064
Loadings*	339.08	64	0.90	0.073	0.063	0.083	0.089
Intercepts	399.98	176	0.87	0.08	0.071	0.09	0.094
Residuals	483.30	182	0.83	0.088	0.079	0.098	0.102
Means	481.84	192	0.84	0.087	0.078	0.097	0.102

*Preferred model

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