Changing Perspectives on Anatomy & Physiology: From Killer Class to Gateway Course

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Abstract

Anatomy and Physiology should be considered a gateway course due to its challenging scope and key role as a foundational prerequisite for many degree programs. Students often encounter gateway classes early in their college career when they are academically vulnerable due to their lack of university experience. A&P teaching methods are evolving to address these issues and favor more positive outcomes. New approaches include emphasizing understanding of course content (rather than relying on memorization) and creating multi-modal learning opportunities. Utilizing active learning techniques allows students to more directly participate in their education and achieve more favorable results than traditional passive methods. Furthermore, unifying A&P lecture and lab classes into a cohesive "studio model" class taught by one instructor may encourage student collaboration and increase active learning. Implementing a formal supplemental instruction program led by peer facilitators supports struggling students and yields promising results. A renewed focus on improving the teaching skills of gateway instructors is integral in creating a learning environment that maximizes academic success. In this paper, we review special issues and problems associated with A&P instruction. We also discuss how changing perspectives on course organization could improve A&P courses.

Keywords: Anatomy & Physiology Gateway courses STEM Education Active Learning

What Makes Anatomy & Physiology a Killer?

Anatomy & physiology (A&P) courses certainly fall under the rubric of science, technology, engineering and mathematics (STEM). At many colleges and universities, health sciences students comprise a majority of the students enrolled in those courses. This adds complexity to the task of designing and teaching high caliber A&P courses. The implication is not that health sciences students are somehow easier or more difficult to teach. Rather, their programs usually require the courses as prerequisites and often culminate in comprehensive licensure exams. These circumstances draw more interested parties into the mix and create more checks and balances regarding the quality of A&P courses. While these conditions are not exclusive to A&P students, they certainly warrant giving A&P classes a detailed look.

Words and phrases such as "daunting," "content dense," "intimidating," "difficult" and "conceptually challenging" have been used by students, faculty and researchers to describe A&P courses (Johnston et al., 2015; Finn & Campisi 2015). Table 1 offers perspectives of the authors. Both of us are former A&P students; one now teaches the course. Like other lower-level college science courses, A&P may be taught in a format involving a single massive lecture and several smaller lab sections. So, lecture and lab may be taught by separate instructors with differing academic expectations and dissimilar teaching styles (Finn et al., 2017). Students often feel so pressured to maintain a high average that they focus on the final course grade, often at the expense of "owning" the content (Eagleton, 2015).

Johnston et al. (2015) note that health science students enrolled in nursing programs are often older individuals who have not been involved in formal education for a long period of time. In other words, they have "gone back to school." Many are first generation college students. The authors see these trends among other health sciences students as well. Like many other STEM courses, A&P is often taught using traditional pedagogical practices that emphasize rote memorization and minimize student participation (Mattheis & Jensen, 2014; Anderton et al., 2016). Professors habitually bemoan the lack of academic preparation among learners (Finn & Campisi, 2015), while students tend to view A&P as a dull course taught in an environment with a low "sense of community" which lacks encouragement. They sometimes identify these issues as contributing factors for their poor performance (Hoskins et al, 2017). Additionally, students are often very reluctant to seek out academic support (such as tutoring) offered by universities (Thomas et al., 2019). High withdrawal and failure rates contribute to low morale for both teachers and their students. Minority students, low-income students and first-generation college students are often overly represented among students who fail or withdraw from gateway courses (Koch, 2017).

Teacher Perspective	Former Student Perspective
I have been teaching anatomy & physiology, and other college biology courses, for over 25 years. I still absolutely love my job and I still get very excited at the prospect of helping my students learn such an interesting subject. Anatomy & Physiology has always been a hard class to teach and a difficult class in which to be a student. I know both of those things firsthand. Yet, certain aspects of my work have become more predictable over the last several years. I feel privileged to be slated to teach two sections of A&P this fall. Teaching that course has, however, become a trying and emotional experience for me. I'll make an effort on the first day to get my students engaged and motivated. Yet, I'll think to myself "You all have no idea what you've signed up for." I will teach as much about study skills as I do about cells, bones and tissues. I'll have my students draw concept maps. I will remind them to do daily reviews and read their textbook. They will hear my earnest warnings about preparing for the lab practical, yet some of them will still not apply themselves. After the first test, more and more of the students will come to me with stories about which health science program they are applying for and what grade they need in my class. I'll push tutoring. I will continually encourage students to ask questions in class. I will reinforce course material in multiple review sessions. Some students will appear overwhelmed; others will nervously turn pages in a book which they have likely never read. As the weeks go by, some students will find themselves hopelessly behind. I will continue to encourage them and make myself available to help. Unfortunately, some students will not take advantage of this; however, most students who follow the course guidelines will succeed. Of those who fail or withdraw, most will ultimately blame me. Dr. Eddie Lunsford (A&P Teacher), Reflective Journal	I certainly left A & P with a greater knowledge of the inner workings of the human body. Admittedly, I may have forgotten some of the material over time. Yet, the course provided me with both a comprehensive biological overview and an enduring framework for adding new information. I still possess a strong enough knowledge base to recognize when gap in my understanding appears. Having this realization allows me to reinforce any areas that have become unclear. Knowing how to efficiently assimilate new information is an especially valuable skill today due to the accelerated pace of innovation in our society. New industries, technologies, careers and opportunities are created (and disappear) at an unprecedented rate. The old saying that change is the only constant in life may apply now more than ever. The ability to quickly understand new information will very likely provide more career opportunities and greater stability in an ever-changing job market. Enhancing these skills will likely be required for success in the future. As a result, the most valuable takeaway from completing this A&P class may have been learning how to approach the art of learning itself. As students, we were taught how to improve time management and maximize memorization of course material with minimal effort. We were also encouraged to ask questions and discuss any concerns we had. These techniques helped me to develop a calm focus that alleviated the sense of being overwhelmed and allowed me to feel that the course demands were manageable and achievable. As a result, the course provided me with better learning methods and an enhanced confidence in integrating and explaining complex ideas. I am also able to make more informed choices about my health and well-being since completing the class. Michael Diviney (Former A&P Student in Allied Health Program), Reflective writing

Table 1. A comparison of A&P teacher and student perspectives

These circumstances often delay student progress into their chosen majors and/or programs of study (Gultice et al., 2015). Sadly, some A&P instructors have responded by watering down their courses to the point that they are ineffective for the students and their program requirements (Johnston et al., 2015). In what follows, we suggest that A&P courses should be treated as "gateway courses." Though the change is not in name only, gateway courses are getting significant attention in recent educational literature. This perspective should change how A&P courses are designed and taught; as well as how students view their role as an active participant in the learning partnership. As we will establish, the gateway model encourages not only change, but informed change driven by data.

What are Gateway Courses?

We should begin by admitting that the college classes now referred to as "gateway courses" were recently called "killer classes" (Koch, 2017). Students typically enroll in gateway courses early in their studies, often within the first couple of academic terms (Pistilli & Heileman, 2017). Unfortunately, for most students, this is a time of great vulnerability for academic success (Nordell, 2009). Students are frequently placed in this situation because gateway classes are often prerequisites that must be successfully completed before students can enter their academic program (Pistilli & Heileman, 2017). Furthermore, gateway courses tend to have high enrollment relative to each institution's typical class size and student-teacher ratio (Koch, 2017).

Faculty who teach gateway courses often lack basic pedagogical skills, despite the fact that they may be highly respected scientists within their field of expertise (Jensen, 2011; Mattheis & Jensen, 2014). It is unlikely that they struggled much when they were students (Nordell, 2009). Yet, they often find themselves under pressure to improve pass rates in

their courses (Pistilli & Heileman, 2017). More often than not, gateway course faculty have little to no skills or experience successfully dealing with struggling students (Norell, 2009).

Students typically struggle a great deal in gateway courses (Pistilli & Heilman, 2017). Specific to STEM gateway classes, Hoskins et al. (2017) report that students often come into classes with only rudimentary study skills. The students tend to rely on study habits that served them well in high school, despite the fact that the college learning model is vastly different and requires students to master much more material while spending far less time in the classroom. Students tend not to understand that much of the responsibility for learning falls squarely on their own shoulders. Also, the students often lack crucial self-assessment skills and are frequently at a loss to adjust their academic strategies when they find that their outdated study habits do not produce favorable results (Nordell, 2009). These factors exacerbate the risk of poor academic performance and contribute to high failure rates. There is a trend toward using institutionally relative rates of D and F letter grades, as well as Incomplete (I) grades and Withdrawal (W) grades to formally identify a gateway course. Incomplete grades are significant in that they may often change to Fs based on school policies (Koch, 2017).

Today more jobs than ever require a college degree. Therefore, college enrollment is generally higher than it has been in years past (Pistilli & Heileman, 2017). All this sets up a scenario where much more is at stake than simply failing a class. Course failures and withdrawals impact financial aid eligibility which, in turn, increases one's risk of dropping out of college (Koch, 2017). Costs of attending college are higher than ever (Pistilli & Heilman, 2017). The logical conclusion is that a great number of unfortunate students run a real risk of not only having their life aspirations dashed, but also leaving school with a mountain of debt and little to show for their efforts. It is at the very least concerning, if not overtly heartbreaking, to see this state of affairs continue unimpeded.

Shifting Perspective & Seeking Solutions

As educators start to view STEM classes as gateway courses, A&P teaching methods are changing. There is a greater emphasis on helping students understand content in lieu of simple memorization (Anderton et al., 2016). The gateway model leads us to view A&P courses for what they are: high-risk classes that are often in need of a major overhaul. In other words, the new emphasis is less about at-risk students and more about fostering a better course framework (Arendale, 2014). In what follows, we will review trends and specific programs being implemented to achieve this goal. These techniques often do not stand alone but work most effectively as part of a comprehensive approach. In fact, what seems to work best is the simple act of providing choices, variety, and multi-modal learning opportunities (Eagleton, 2015; Anderton et al., 2016). Table 2 summarizes the essential recommendations for change.

Changing perspectives from	Changing perspectives to
Targeting at risk students only	Targeting high risk courses
Separating lecture & lab	Integrating the whole course experience
Lecture as primary pedagogical tool	Use of various techniques for teaching
Teacher as content expert	Teacher as content expert with high teaching skills
Students sink or swim	Students are encouraged, coached & nurtured
"Tutoring is available"	Supplemental instruction built into course
Students passively participate in lecture	Students become skilled, active learners
Study skills assumed	Study skills & metacognition are taught
Professor for lecture, assistant for lab	Professor teaches both, supported by SI facilitator
Most feedback for students from graded exams	Regular, constructive, targeted feedback for students
Professor & department hope for a better year	Set goal → implement change → track improvement

Table 2. Recommended patterns of changing perspectives in A&P courses.

Emphasizing active learning.

The concept of active learning is simple but often misunderstood. Active learning is the process of directly engaging students in the learning process. For example, groups of students in a lecture hall who are simply taking notes are likely not participating in active learning. However, students who work in groups and who are challenged to think during class are more actively participating in the learning process. Freeman et al. (2014) completed a meta- analysis

concerning the impact of active learning in STEM courses. They found that implementing these classroom strategies greatly bolstered exam scores and course averages when compared to traditionally passive methods. Finn & Campisi (2015) also noted better attitudes, specifically among A&P students (and a higher retention rate) when active learning was fostered. Incorporating active learning does not mean doing entirely away with traditional teaching methods like lecture (Andreton et al. 2016).

Specific examples of active learning opportunities appropriate for A&P courses abound. For example, students may collaborate in small groups to master content objectives (Finn & Campisi, 2015). In the author's classes**,** students work on a semester-long concept-mapping project. Maps are handed in with each unit of study. A bit of class time is sometimes devoted to mapping in groups. Students may elect to hand in a combination of individual and group generated maps. Also, students share half the responsibility for grading their submissions with the teacher.

Lately, there has been a great increase in technological learning aids such as medical imaging programs and simulations that may be used with success. Examples include the Anatomage™ Virtual Dissection Table, Visible Body©, Anatomy & Physiology REVEALED® and many others. In the absence of these items, simple activities like painting muscles or vessels on tee shirts or making clay anatomical models may be pursued (Anderton et al., 2016). Belanger et al. (2018) described an inquiry activity whereby their A&P students not only gained sound skills in scientific processes but also honed their microscopy skills and analytic proficiency. Moreover, the students learned a great deal about the pathophysiology involved in diabetes mellitus. A&P students may also benefit from case-based scenarios. Hilvano et al. (2014) described how the health science students in their study prepared group-based poster presentations. Participants were assessed individually and in cooperative groups. The results included increased content knowledge and better attitudes toward the course. Finally, Dyer & Elsenpeter (2018) remind us of the importance of tracking the success of attempts to foster active learning by completing statistical analyses. Qualitative data, from student questionnaires or focus groups, may assist as well (Hilvano et al. 2014; Finn & Campisi, 2015).

Integrated lecture and lab.

As previously noted, gateway STEM courses, like A&P, are traditionally taught in oversized lectures accompanied by smaller laboratory sections. A growing trend is to integrate both parts of the course into a unified experience (Finn, et al. 2017). At our school, due partly to its smaller size, we have made a choice to do just that. Despite growing enrollment, scarcity of lab space and scheduling challenges, we try to maintain the pattern of teaching lab and lecture in the same room (a laboratory room) and with a single instructor. Finn, et al. (2017) noted that this practice is sometimes referred to as the "studio model." It involves longer class periods and a greater emphasis on collaborative learning. Students tend to view the experience favorably, which may also increase learning. We suggest that even large universities may benefit by experimenting with this model. For example, the course could meet twice per week for three hours, instead of meeting three times per week for an hour-long lecture and then returning for a separate three-hour lab. Combining lab and lecture presents opportunities to implement new teaching strategies and integrate targeted lab activities into the typical routine.

Providing formalized supplemental instruction.

There is a lot to be said for the value of a good tutoring experience in STEM courses and elsewhere. The idea of supplemental instruction (SI) takes that model into new territory (Eroy-Reveles, et al., 2019). Numerous variations on the basic theme exist, but the gist is that the experience is embedded within the course as enrichment instead of being a separate activity for poorly performing students (Arendale, 2014). This leads to a major advantage in diminishing the frequent sense of imputation, and the extra effort involved, in seeking out and utilizing a tutor (Thomas et al., 2019).

In larger universities, graduate students may lead SI the way they currently teach lab sections (Hoskins et al., 2017). Academic peers may also be leaders of SI. Arendale (2014) uses the phrase "Peer Assisted Learning" (PAL) while Finn & Campisi (2015) call the practice "Peer-Led Team Learning" (PLTL). Peer facilitators are required to have recently completed, and excelled at, the course they are leading. In addition, facilitators often receive formal training focusing on the pedagogy of teaching small groups. They may also attend class and lab meetings along with their SI student participants. Enrollees attend regularly scheduled meetings (often weekly) where they collaborate and review material previously presented in class. Some institutions make attending sessions optional, others mandatory. The desired outcome is a comfortable environment where students cooperate with each other and where facilitators pass along their knowledge to help the cohort succeed (Arendale, 2014; Finn & Campisi, 2015). Another component of SI may involve coaching students to develop stronger study skills and better learning strategies (Arendale, 2014). Nordell (2009) notes that

metacognitive skills, critical thinking, and self-assessment may create positive outcomes when they are emphasized in STEM courses. To assist with individual studying and SI work, students and facilitators may be provided with clear course objectives, study guides and other handouts. An advanced study organizer, similar to the one shown in Table 3, may help guide students to more effectively manage the complicated course organization. That handout is used in the first author's class. It includes tips for managing the heavy emphasis on microscopy in mastering the course objectives for that particular topic in class. There are also reminders about basic things like reading, reviewing, and keeping track of handouts, as well as where to locate reading assignments. Students frequently need those reminders, particularly during the early weeks of the course.

A single SI session or two may be offered early in the semester or implemented as a regular and ongoing intervention. Nordell (2011) also describes an effective seminar focusing on college study skills that is required for all incoming freshmen. Various colleges have gone so far as to create course-specific supplemental instruction meetings that require attendance. They are listed in the departmental class schedule and generate revenue from tuition (Eroy-Reveles et al., 2019). For example, all students taking a "regular" A&P course may also be required to attend a supplemental co-requisite class. We recognize this may be a challenge, particularly in colleges like ours where degree and certificates programs are already burgeoning with required hours. Yet, the improvements may well justify such an undertaking. In summary, SI programs (such as PLTL and PAL) have demonstrated empirically quantifiable results that may increase pass rates (Finn & Campisi, 2015; Thomas et al., 2019).

Improving instructor preparation and skills.

As documented above, faculty who are involved in a gateway course instructional role may be among those who have the poorest pedagogical skills. This is often due to the fact that they were never required or encouraged to take courses to prepare them to be more skilled and effective in their teaching (Norell, 2009; Jensen, 2011). Mattheis & Jensen (2014) noted that one of the biggest general challenges to improving A&P instruction stems from a resistance to change on the part of instructors. In higher education, there seems to be a pervasive preconception that "teacher training" does not really matter, even (or perhaps especially) for challenging college STEM courses. Jensen (2011) reviews numerous pieces and types of evidence that effectively refute and shatter this myth.

We recommend that all A&P instructors (regardless of their current pedagogical preparation) actively seek out and participate in opportunities to refine their teaching skills. A&P instructors could, for example, enroll in a course or two offered by their university college of education. There are education classes aimed at science teaching methodology, effective classroom testing and measurement, and educational psychology. Chances are good that faculty in education and/or psychology would welcome the opportunity to collaborate with A&P instructors to develop shorter, more targeted workshops that assist with A&P gateway course goals. We encourage A&P faculty to read books, take online courses and/or attend seminars about effective teaching practices. Even the best prepared professor may benefit from enhancing content preparation. For example, simply by becoming a student again, a veteran of A&P instruction may discover an exciting new technology or a unique approach to explain a difficult physiological concept.

Summary

In this paper, we have presented a review of special problems and challenges associated with college and university A&P courses. These challenges encompass not only the student population but also the faculty and entire institutions of learning.

Additionally, we explained the concept of gateway courses and reviewed why A&P is increasingly being thought of in that framework. Finally, we offered several examples, both from the literature, and from our own experiences, to assist others in changing their perspectives on how to best design and deliver a quality A&P gateway course. We encourage professors, department chairs and other interested parties to examine existing pass/fail rates, student averages and student satisfaction surveys in their A&P courses. The gateway model would next require formulating goals for improvement. Finally, selected interventions would be implemented, and their progress tracked. We challenge our colleagues to participate in initiatives designed to improve their own A&P courses. We encourage them to use a variety of qualitative and quantitative measures, and to report their findings to the larger community of college A&P educators and other interested STEM education participants.

Topic 2: Histology & Integument: Pulling it All Together This is a shorter unit but make sure it does not sneak up on you as you're studying for Topic 1. Plan ahead and budget your time well. Laboratory is particularly important in understanding the histology objectives.	
Read and Review	**Lab Work**
Read Textbook: Use syllabus & objectives. The textbook glossary and index will help too. **Make Concept Maps** as you read **Review daily:** refine concept maps as you review. Look for verb cues on objectives like "list" or "label" or "match" **Preview lab procedures:** See syllabus each week **Mark Progress**: Record reading & review dates on the back of this handout **Emphasize lab as you study**; especially on histology **Stop Studying** on the day before the test. This will help you relax and assist your short-term memory	**Utilize feedback** you got on the previous labs to improve your microscopy diagramming techniques **Use the Lab Procedure** to guide your work; not the exercises or any pages to hand in. **Spend extra time on microscopy work.** Make careful diagrams as you follow the lab procedure. Base your diagrams on what you observe while looking in the microscope, not from micrographs or from someone else's paper. Use lab book, atlases and textbook to help with labeling and identification. **Work collaboratively with your lab group** but make sure you actively participate. **On lab week 4** make sure you study the models of the skin as you work **With any Remaining Time:** Verify your progress with "Lab Practical II Objectives" handout; review models and slides for practice **Begin work on any pages to hand in**: This should be the last thing you use your time for during lab. Collaborate with others but do not copy their work. Look up answers in the lab procedure, textbook or other sources. Have any assigned pages all finished and ready to hand in on the due date. **As noted on the lab schedule** from the Syllabus…think about getting a jump start on studying the skeleton
During Class	**Other Things You Can Do**
Ask questions based on your previous days' review **Follow along** with the skeletal outline during lecture **Make notes** to clarify reading & concept mapping **Participate** by asking questions, watching videos, contributing to discussion **On Test Day:** Avoid review and study on that day. Walk into class with your concept map(s) finished; include your name and numerical grade (zero to 10). Hand them in first thing. Realize that you also should be prepared to continue in the next unit following the test. **REMEMBER:** No late concept maps are accepted. If you're absent send them on or before the test date.	**Ask your teacher** for extra help by e-mail or during an office visit **Study with others** if your schedule allows **Use outside assistance**: Go by the Learning Assistance Center (LAC) and/or ask about tutoring on a regular, or as needed, basis **Use other references:** supplemental books, online resources, YouTube videos **Review histology slides** in the library; they have several but not a complete collection **Plan Ahead:** Don't forget Topic III is forthcoming and needs your attention. **Utilize review questions** in textbook and/or items in lab book which were not assigned.

Table 3. Example of advanced organizer from second A&P topic unit.

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