

Student Performance and Perceptions of Adopting the Flipped Learning Approach into an Integrated Anatomy and Physiology Course

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Two pedagogical models aimed at promoting active learning include the flipped learning model and the integrated studio model. Student performance in Anatomy and Physiology (A&P) was compared when the course was flipped+integrated (FI) to when the course was solely integrated (I). Students' perceptions of the (FI) instructional approach were assessed using the Student Assessment Learning Gains survey; narratives identify engaging in course content through pre-recorded lectures as an important positive attribute for enhancing student engagement, hands-on application, confidence, and understanding. Student performance was assessed using the rates of unsatisfactory/satisfactory grades, exams, and formative assessments. More students earned A's and B's and fewer earned C's in the (FI) year compared to when the course was integrated. Final exam grades were higher during the integrated semester; however, unit written/practical exam grades and formative assessments were higher during the (FI) semester. Combining the flipped learning model with the integrated studio model may further improve student performance and satisfaction in A&P compared to when the course is solely integrated.

Keywords: flipped learning, integrated lecture and lab, health science courses, active learning

INTRODUCTION

Active Learning

The modern advancements in video and audio technology, the growth of available reliable online resources, and developments in cognitive science combine to challenge the traditional notion of teaching and learning to develop a more interactive and collaborative active learning environment. Active learning engages students in the process of learning through interactive activities, retrieval practice, in-class discussions, and hands-on experiences, as opposed to passively listening to an expert. It emphasizes higher-order thinking and often involves collaborative group work (Freeman et al., 2014). Evidence shows that engaging students in active learning enhances their learning outcomes and improves their motivation and attitudes (McLaughlin et al., 2014). Freeman et al. (2014) did a meta-analysis of 225 studies to compare

student performance in courses with at least some active learning versus traditional lecturing and concluded that active learning leads to increases in exam grades that would raise average grades by half a letter and that failure rates with traditional lecturing increase by 55% over the rate observed when active learning is implemented. With extensive evidence-based support for active learning and the need for students to construct their own understanding and knowledge, more STEM (science, technology, education, math) based college courses have shifted away from traditional lectures to adapting and implementing instructional modes of delivery aimed at promoting active learning (Henderson et al., 2011). Two modes of delivery that drive active learning include the integrated studio model and the flipped learning model.

Integrated Studio Model

In an integrated instructional approach, longer class periods integrate didactic instruction with hands-on laboratory experiences within the same class sessions. These include small classes, group collaboration, close interaction between instructors and students and among students, minimized lecture instruction, and incorporation of learning activities, group work, problem-solving, investigative and experimental work (Freeman et al., 2014). Several studies have reported positive student satisfaction and improvement in academic performance in integrated courses in STEM disciplines including A&P (Finn et al., 2017; Peacock et al., 2020; Peacock et al., 2022). Finn et al. (2017) and Peacock et al. (2020) reported improvements in student performance in rates of satisfactory/unsatisfactory grades, practical exam grades, and quiz grades when the gateway health science course was taught using an integrated model compared to the traditional model; students also identified the ability to immediately apply theoretical knowledge in lab activities as an important positive attribute improving student learning in the integrated model.

Flipped Learning Model

Evidence supports the effectiveness of the flipped learning model as another form of active learning. In the flipped learning model, what is traditionally done in class (instructor lecture and student note-taking) is done prior to class, while what is done outside of class (assigned problems, case studies, etc.) (Bergmann & Sams, 2012), is completed during the scheduled class time. In this model, students are expected to take the lead in their learning (Al-Samarraie et al., 2019). Engaging in pre-class work (PCW) allows students to engage in and learn outside of class, at their own pace, and on their own time. This model allows the learner to view the lecture, pause, repeat, and write down informed questions or points of confusion while also providing students with foundational knowledge prior to attending class. In-class time is then spent not only answering questions to clarify the concepts but more importantly providing students with the opportunity to construct their own knowledge through practical application, lab integration, experiments, case studies, and assigned problems (Al-Samarraie et al., 2019; Bergmann & Sams, 2012). Tune et al. (2019) assessed the effectiveness of a traditional lecture-based (passive) curriculum versus a modified flipped classroom (active) curriculum in cardiovascular, respiratory, and renal physiology, and reported that the flipped class model led to improvements in student performance in all three content areas. Additionally, McLaughlin et al. (2014) reported a significant increase in students' perceptions of the following items "pre-recorded lectures greatly enhanced my learning; learning key foundational content prior to coming to class greatly enhanced learning of course material in class; interactive, applied, in-class activities greatly enhanced my learning, and in-class discussions of course concepts with peers greatly enhanced learning" (p. 240).

In response to the growing evidence of the effectiveness of the integrated and flipped learning models, and in an effort to continue improving student performance and engagement in the challenging first-year required A&P gateway course, we combined a remote flipped learning model for 8-weeks when COVID-19 shifted all face-to-face instruction to an online learning environment (Peacock et al., 2022). Students' perceptions were positive in face-to-face and in online delivery. Student performance was higher on both face-to-face and online exams for 2020, compared to the same exams in face-to-face 2019; no differences were observed in exam grades in 2019 and 2020. No unsatisfactory grades were noted. The sudden shift to online learning had no negative effects, and in some cases, improved student performance (Peacock et al., 2022). Nevertheless, it is possible that, in part, the positive perceptual responses and improved student

performance were a function of the sudden pivot from face-to-face to online learning, or were unique to particular courses or groups of students or instructors. Therefore, it is important to determine whether combining flipped learning with integration is sufficiently robust to continue to generate positive and consistent student responses and improved performance despite the enrollment of different students, instructors with different levels of experience, and a different learning environment. Additionally, it is important for colleges and universities to assess how a change in the instructional approach may impact student learning and to adapt effectively to facilitate students' ability to achieve learning outcomes. Therefore, in the current study, we analyzed and compared student perceptions and performance in spring 2021 when the flipped+integrated (FI) instructional approach was implemented for an entire 15-week semester to spring 2019 when the course was integrated only (I). Both of these semesters were fully face-to-face.

The analyses allowed us to address the following research questions:

- 1) Did the positive student response to the (FI) instructional approach persist within A&P II over repeated offerings and during a full term of face-to-face instruction?
- 2) Did the (FI) instructional approach result in better performance compared to integration only, as measured in several ways?
- 3) What features of course design and delivery appeared to be most useful to students in the (FI) instructional approach?

METHOD

Context of the Study

The current study was conducted at a private, independent, coeducational institution with more than 4000 full-time undergraduates and over 1200 graduate students from 45 states and 48 countries, comprising schools of liberal arts, science and engineering, nursing and health sciences, education and social policy, and business. The School of Nursing and Health Sciences enrolls 780 undergraduate majors including nursing, exercise science, health science, nutritional sciences, public health, rehabilitation sciences, and undeclared health sciences. Four master's degree programs enroll 100 students; many graduate students hold fellowships as teaching assistants (TA's). The College's Institutional Review Board for human subject research approved this study (FY22-23-30).

Anatomy & Physiology II

(I) Approach Spring 2019

In spring 2019, fifty-nine students enrolled in three integrated sections of A&P II which were taught by three different faculty instructors each with a teaching assistant. The instructors included one full-time lead instructor and two adjunct instructors. To ensure consistency across all three sections, the lead instructor managed the course learning management system and communication among all three sections, as well as developed all course content and assessments. For this reason, the only difference across sections was the instructor. A typical integrated class session involved a series of short lectures taught live by the faculty instructor followed by the immediate application of material through guided laboratory activities primarily focused on learning the structures and functions of each anatomical system. Online assignments, all of which are associated with the course text (McKinley et al., 2019) were completed for each anatomical system and submitted through the McGraw Hill Connect Website. The online assignments ensured that students completed chapter reading, and allowed students to review their reading and practice answering questions similar to unit written and practical exams. The weekly lab assignments aligned with each system and encouraged students to connect course content with hands-on activities. Students were expected to submit the lab assignments at the end of each bodily system. Unit exams which included both a written and practical component were administered during class time. A cumulative final written and practical exam was administered during class time during final exams week.

(FI) Approach Spring 2021

Based on our findings (Peacock et al., 2022), in spring 2021, we combined the flipped learning model with the integrated approach in three sections of A&P II when the course was back face-to-face with the goal to enhance active learning, performance, and perception beyond integration alone. A fourth section in spring 2021 followed an identical instructional approach as face-to-face, however, was taught synchronously online. All course content was organized by key topics into modules and pre-recorded for students by the lead instructor. Students were expected to view the assigned PCW modules (PCW) prior to reinforcing the specific content through interactive lab activities and hands-on applications. For example, if the class was held on Tuesdays and Thursdays, students were expected to submit PCW every Monday and Wednesday to ensure adequate feedback prior to the in-class session. While viewing the pre-recorded modules, students were required to complete the Cornell Note-Taking Template (Pauk & Owens, 2010). This template was designed for the PCW and included notes, questions, and a summary component. Due to the nature of flipped learning, more in-class time was spent on the application of course content through in-class discussions, retrieval practice, and guided interactive activities, which were developed when the flipped learning model was adapted and implemented into the integrated model. Requiring students to complete the PCW in their individual space prior to class, allows more time to be devoted to active integrated learning during the group time, compared to when the course was just integrated. For example, during class time, students worked collaboratively in groups to discuss questions from the PCW and to complete recall activities relevant to the PCW content. The discussion questions as well as the recall activities were then discussed as a class. The interactive guidebooks took the place of the weekly lab assignments and included a series of active learning activities which required students to be hands-on with the anatomical models and the Anatomage Table™ during class time but, also encouraged students to work collaboratively with their peers to complete hands-on and written activities related to course content. The online assignments completed through the McGraw Hill Connect Website were almost identical in 2021 as compared to 2019, (McKinley et al., 2019). Unit exams as well as the final and practical exams were the same in 2021 when the flipped learning model was combined with integration. Demographics for A&P II in spring 2019 and 2021 appear in Table 1; Grading policies for spring 2019 and spring 2021 appear in Table 2.

TABLE 1
STUDENT DEMOGRAPHIC DISTRIBUTION FOR A&P II %

	<i>Spring 2019</i>	<i>Spring 2021</i>
	<i>(I)</i>	<i>(FI)</i>
# of Students	59	80
Male	43%	21%
Female	57%	79%
Freshman	72%	61%
Sophomore	28%	29%
Junior	0%	6%
Senior	0%	4%
Health Science Majors	91%	88%
Other Majors	9%	12%

TABLE 2
COMPARISON OF A&P II GRADING POLICIES IN SPRING 2019 TO SPRING 2021

<i>Spring, 2019 (N=59)</i> (I)		<i>Spring, 2021(N=80)</i> (FI)	
Exams		Exams	
Exams (Written & Practical)	40%	Exams (Written & Practical)	40%
Final Practical Exam	10%	Final Practical Exam	10%
Final Written Exam	10%	Final Written Exam	10%
Other Assignments		Other Assignments	
Connect™ Assignments	25%	Connect™ Assignments	15%
Weekly Lab Assignments	15%	Interactive Lab Guidebooks	15%
		Pre-Class Content Work	10%
Total	100%	Total	100%

Evaluation Measures

Students Perceptions

At the end of spring 2019 (I) and spring 2021 (FI) terms, students completed the Student Assessment of Learning Gains (SALG) survey; a validated online tool that collected both quantitative and narrative responses, regarding the helpfulness of various aspects of the course to student learning, and gains made in various skills and learning (Seymour et al., 2000). Faculty developed additional numerical questions for each term related to integration and flipped+integration using a 5-point Likert scale. A box for narrative responses was added for additional comments on each instructional approach (Table 3).

To compare students' perceptions of various components of A&P II, independent group *t-tests* were performed using SPSS with an alpha level of $p < .05$. For narrative responses among students, researchers read and categorized the narrative comments for all courses as positive, and negative, or unrelated, and then assigned them to major themes. The relative frequencies of the appearance of the major themes were then calculated. For narrative responses among students, grounded theory analysis was performed. According to Strauss (1987) and Strauss and Corbin (1990), grounded theory analysis is an approach to exploring the data when the researcher does not have any prior assumptions regarding the research topic since data are not collected prior to any former conclusion. In line with this theory, one researcher read and analyzed all of the students' responses for all narrative questions using the following process: 1) created categories and identified codes, 2) determined the main themes and supporting data. The relative frequencies of the appearance of the major categories were then calculated. This process was repeated by the researcher for a second separate analysis.

Students' Performance

To assess changes in performance in A&P II, numbers of unsatisfactory grades (C-, D, F), as well as withdrawals from spring 2019 (I) were compared with spring 2021 (FI). For the integrated semester, 2019 was chosen for analysis because it was entirely in-person and most consistent with spring 2021; course content, exams, and online assessments were identical in both years.

Grades on summative assessment including unit exams, each covering a different body system as well as grades from the final written exam and final practical exam from spring 2019 were compared with exam grades from spring 2021 using independent group *t-tests*. Outliers were determined and removed if significant. The content and the format of the in-class exams as well as the final written and practical exams were very similar across models. Practical exams in both terms were based on timed identification of structures and functions.

Students' performance on formative assessments in spring 2021 (FI) was compared to spring 2021 (I) using independent group *t-tests*. In spring 2019 (I), formative assessments included online assignments and

weekly lab activities whereas, in spring 2021 (FI), formative assessments included online assessments (same as spring 2019), interactive guidebooks, and PCW. The online connect assignments were identical for 2019 and 2021. The interactive guidebooks took the place of the WARI assignments to provide students with more hands-on applicable learning. Lastly, PCW was added as an expectation of the course when the (FI) approach was adopted and implemented. All performance analyses were performed in SPSS, and alpha was set at $p < 0.05$.

RESULTS

Student Perceptions

Numerical Responses

Data on the mean scores for the average ratings of the selected perceptual questions are shown in Table 3. Seventy-six percent of the students in spring 2019 and 87% of the students in spring 2021 completed the SALG survey. A five-point Likert scale was used to rate the helpfulness of various aspects of the course, where 5=great help/gain, 4=much help/good gain, 3=moderate help/gain, 2=a little help/gain, 1=no help/gain. Of the 12 selected items relevant to the instructional approach from the SALG survey, all had means of 4 (much help/good gain) and above, with 9 of 12 at 4.5 and above. Two items were *directly* related to flipped learning. The mean score for students' perceptions of PCW was 4.6(.72) and for pre-recorded lectures, 4.4(.87) the mode was 5 for both items. In seven cases, the same question directly compared students' perceptions of learning in the flipped+integrated approach to integration only. The mean score for students' perceptions of the helpfulness of the instructional approach relative to their learning in spring 2019 (I) to spring 2021 was 4.6(.64)(I) and 4.5(.81)(FI); no significant differences were observed between the two instructional modes of delivery, $p = .21$. Similarly, no differences were observed in students' perceptions of how the class topics, activities, reading, and assignments fit together, participating in class discussions, attending weekly review sessions, ability to communicate physiology, and confidence between the two models, $p > .05$. Students rated their understanding of "main concepts" as the highest during the flipped+integrated approach 4.7(.52), compared to a 4.5(.71) during integration only $p = .01$.

TABLE 3
A&P II SALG SURVEY

	Spring, 2019 – (I) Students (n = 50/59; response rate 84.7%)		Spring 2021 – (F+I) Students (n = 61/80; response rate = 76.25%)		
How much did the following aspects of the class help student learning?	(I) (m(sd))	Mode	(F+I) (m(sd))	Mode	T-test
The Class Overall					
The instructional approach.	4.6(.64)	5	4.5(.81)	5	0.21
How the class topics, activities, readings, and assignments fit together	4.6(.64)	5	4.6(.74)	5	0.32
Class Activities					
Participating in discussions during class	4.3(.78)	5	4.4(.76)	5	0.10
Attending weekly review sessions	4.6(.71)	5	4.5(.71)	5	0.46

Assignments, graded activities and test					
PCW			4.6(.72)	5	
Pre-Recorded Lectures			4.4(.87)	5	
Understanding of Class Content					
The Main Concepts	4.5(.65)	5	4.7(.52)*	5	0.01*
Increase in Your Skills					
Study Skills			4.6(.62)	5	
Ability to Communicate about physiology	4.6(.67)	5	4.4(.67)	5	0.22
Critical Thinking Skills			4.5(.62)	5	
Class Impact on Your Attitudes					
Confidence	4.4(.73)	5	4.5(.62)	5	0.30
Enthusiasm of the Subject			4.5(.62)	5	

Note. 5=great help/gain, 4=much help/good gain, 3=moderate help/gain, 2=a little help/gain, 1=no help/gain

*Students' rating of their understanding of "main concepts" was significantly higher in spring 2021 (flipped+integrated) compared to spring 2019 (integrated only), $p = .01$.

Narrative Responses

In spring 2021 (FI) students were asked open-ended questions on the SALG survey pertaining to the features of the course that were most helpful in facilitating student learning. The most commonly identified specific aspects of the course are noted below. Although 61 students returned the survey, not all students answered every narrative question. Each question had a variety of responses and themes identified by 10% (6) or more of the responses are reported here. Comments made by few students or considered to be too general to classify ("good" or "I like it") and those considered to be irrelevant to the question are not represented. The quotes below expand on why and how these features were considered helpful. Quotes include a non-identifiable participant code to allow for source identification.

Question 1: Students were asked to comment on how the instructional approach facilitated their learning. In response to this general broad open-ended question, students (13) commented most frequently that the class was very well organized, with a clear integrated course calendar identifying assignments, due dates, and other aspects of the course. Others (9) named the PCW (videos and associated assignments due before class) as very helpful, along with clear explanations of material (6), and helpful assignments (6).

"Doing the PCW helped me understand what was being taught in class much more as I was already a little familiar with the material when I arrived at class. It also helped to have a TA in the class that offered flexible office hours and walked around for individual help during class." [Student (S)9]

"Viewing the pre-class videos and taking notes before we were taught the material was difficult at first but as the semester continued, it deepened the discussions we were able to have in class which was helpful." [S53]

"The instructional approach to this class was a great help because the instructor did not just repeat what was given to us prior to class. It was discussed in a way that expanded my thinking." [S61]

"I really loved the course calendar and how we knew when exactly everything was due and how to find it. It made my life so much easier." [S16]

Question 2: When asked how the course change the ways students' study/learn, students indicated that they were motivated to invest more time and effort into studying (10) and to study consistently (10). Other students (9) stated in general that their study skills improved.

"I studied so much for this course than I ever had in any course my entire life but everything was set up in a way I can be successful." [S12]

"It has shown me that studying needs to be a consistent activity in order to do good on a test. These extra hours of review can make or break a person's grade/experience in the class." [S15]

"This class has changed the ways I learn and study by making my brain think beyond what we are discussing in class. I have been able to connect topics to other topics in my other classes such as nursing." [S24]

"I had to learn more time management. It also helped me learn to organize my notes while taking them which would assist me when studying. I would have them organized so that when I went to study, they were ready. I also used the guidebooks to study 99% of the time which helped me gain key information." [S32]

"It definitely taught me to grasp the content on my own and to learn that the content has to be reviewed on my own time and not just in class time." [S37]

"I think that this class has definitely helped me a lot in really understanding the way that I learn and process information between writing it down, having it explained to me, and seeing it physically in front of me helps me understand the information in the best way." [S39]

Question 3: When students were asked what would they keep the same and what would they change if they had to take this course again, the most common response to this question was that the course should stay the same with no changes (29). Others (10) indicated a desire for more visuals, the use of models, and hands-on activities.

Question 4: When students were asked to comment on how the resources in the class helped their learning, many (21) commented on the usefulness of the organization of the class integrated around Google Classroom, Google Calendar, and Google Docs, as well as the use of the Notability app for notetaking. The resources that allowed students to visualize anatomy were also mentioned (11), along with the high level of organization of the class (6).

"I liked using google classroom to turn in my assignments as it is something I'm already familiar with using and it's easy to work with the google docs I usually work on for this class's assignments. However, sometimes I did feel like the PowerPoint slides were not the most engaging or organized to help me find all of the information I was looking for." [S9]

"The visuals really helped and I think they could be incorporated more. Maybe as an extra activity, we can do Kahoots with similar pictures to what will be on the practical. That way there are no curveballs when it comes to the practical and we can really make sure that we know what we are identifying." [S15]

"I think the screen sharing with notability and the PowerPoint slides as well as using visible body helped my learning. Seeing the words and images instead of just hearing them allowed me to be able to learn better as I am more of a visual learner." [S32]

“Technology was such a blessing this semester. I just loved how accessible notes were on Notability. I could take my iPad anywhere because it is so small and review at random times throughout my day so my study time could be broken up nicely.” [S47]

Question 5: When asked to provide feedback on how the graded assignments impacted their learning, many students (29) indicated that these assignments provided them with the ability to check their understanding of the material, and to prepare for exams (6).

“Seeing where I made a mistake helped me learn why my answer was wrong and why the correct answer was right.” [S42]

“I think the exams in class, the Connect quizzes, and all other graded activities helped me SO much. I thought it was very fair and the work helped confirm to me that I understood the material well after hard work put in!” [S47]

“It showed what I got wrong and sometimes when I was taking the tests or quizzes, I thought I got something right and then it turns out I got it wrong and to see how I messed it up helps my overall learning.” [S54]

Question 6: When students were asked to comment on how the graded activities and tests could change to improve their learning, several responses (12) indicated that no changes were needed. Others (10) expressed a desire for getting feedback by having tests and copies of online assignment responses returned to be used for the review. Some (6) felt the Connect assignments could be more applicable to what they needed to learn.

“I think that graded activities and tests really covered the most important material to know for each of the systems, there was never anything on the tests that were not discussed in class or confusing on the exam that didn’t make sense to me.” [S39]

“In all honesty, I don’t find the Connect work to be at all beneficial to my learning. I think I would be completely fine not using it.” [S51]

“Connect homework being more applicable and somehow being to look at our tests after they are graded to learn from where we went wrong and be ready to see similar questions of the final.” [S5]

“It also helped me learn the right answers if I got it wrong I looked for what the right answer was.” [S42]

Question 7: Students were asked to comment on how the PCW helped their learning. In all, 50 students commented positively on the usefulness of the PCW. The main theme (39) in this question was the ability to understand the material for a given class before the class meeting.

“PCW and the videos associated were very helpful, allowed me to have a general understanding going into the class so that I was able to focus more on what the professor was saying and build off of the knowledge I gained from the PCW.” [S5]

“The PCW helped a lot in letting me become familiar with the material before I even get to class where I’ll get even more detail about the topic. The only thing I would change is the length of some of the videos were lengthy, but it makes sense as it was usually on

complex topics. I just noticed that I would lose focus during longer videos rather than shorter ones.” [S9]

“The PCW helped because we were able to go into class knowing some details about the chapters. We didn’t have to take the time to go through the chapters in detail which would’ve taken time away from class. Instead, we were able to go into more detail and ask questions relevant to the work. I liked that the videos were the notes as well as added information from the voice-over.” [S32]

Although no responses suggested eliminating the PCW, some students (6) found some of the videos to be too long.

“The only thing I would change is the length of some of the videos were lengthy, but it makes sense as it was usually on complex topics. I just noticed that I would lose focus during longer videos rather than shorter ones.”

“I liked watching the pre-class videos because they gave me a foundational understanding of the material before coming to class. Some of them were a little bit longer and could have been reduced for time purposes. Overall, they were very helpful and clear.” [S49]

“Although this may be difficult to change, I think I benefited more from shorter PCWs. They were more concise and didn’t leave you feeling overwhelmed. This helped a lot when preparing for the class the next day.” [S15]

Question 8: When students were asked to comment on how the class changed their attitude towards the subject, many comments (26) stated that they found what they were learning to be enjoyable and interesting and motivated them to want to learn more (7).

“Learning about the physiology process has made me more interested in taking more classes like this.” [S59]

“Last semester I wasn’t sure if I wanted to stay in health sciences major but after this semester of anatomy, I decided I want to. I found this class very interesting and the way it was taught helped a lot.” [S54]

“I began taking this class not as interested but quickly gained interest and enthusiasm toward this class.” [S26]

“Understanding the different topics, makes me motivated to work hard for this course and do extra stuff besides the course itself. Also makes me motivated to go further in this topic.” [S38]

“It’s helped me realize how interested I am in these types of classes and have helped me choose my career path.” [S21]

“I think this class helped give me perspective on the things that I want to do in the future and it showed me how hard it would be to get there.” [S15]

“It made me like the subject more and want to keep learning more.” [S8]

Other responses (6) indicated that the course made the student more comfortable with the subject and that they developed more confidence in their ability.

“Last semester I struggled in A&P I so I was nervous about this course but it made me feel more confident with this material and more confident in perusing a career that involves this material and I really liked the topic discussed.” [S42]

“I just feel more comfortable with the subject and I feel I have a strong foundation.” [S12].

Student Performance

Satisfactory/Unsatisfactory Grades

The rate of satisfactory (A/A-, B+/B/B-, C+/C) and unsatisfactory grades (C-, D, F) and withdrawals (W) in A&P II in spring 2019 were compared to rates in A&P II in spring 2021 (Table 4). Students must earn a C or better to enroll in the next health science course in the curriculum. The frequency distribution of grades shifted from the 2019 semester when the course was (I) only to the 2021 semester when the course was (FI). Specifically, the peak of the frequency distribution of grades shifted from the B range in 2019 to the A range and from the C range to the B range in 2021. While the unsatisfactory rate and withdrawals (C-, D, F, W) did increase to 5.00% in 2021 from 1.7% in 2019, the distribution of satisfactory grades shifted in a positive direction, where 88.7% of students earned a B- or better in 2021 compared to 77.6% in 2019, with 16.0% fewer students earning a C+ or C in this course.

TABLE 4
RATE AS (%) OF SATISFACTORY/UNSATISFACTORY A&P II GRADES IN SPRING 2019 AND SPRING 2021

	<i>A/A-</i>	<i>B+/B/B-</i>	<i>C+/C</i>	<i>C-,D,F,W</i>
A&P II				
Spring 2019 (N=59) (I)	27.6	50.0	22.4	1.7
Spring 2021 (N=80) (FI)	51.2	37.5	6.3	5.0

Summative Assessments: Unit Exams & Cumulative Final Written and Practical Exam Grades

There were significant differences in final written or practical unit exams between spring 2019 and spring 2021, $p < .05$ (Table 5). Exam grades covering six bodily systems were significantly higher in 2021 for unit exams 1, 3, 4, and 6, ($p < .05$); unit exams 2 and 5 grades were also higher in 2021 compared to 2019, although not statistically different (Table 6).

TABLE 5
COMPARISON OF CUMULATIVE FINAL WRITTEN AND PRACTICAL GRADES IN A&P II IN SPRING 2019 AND SPRING 2021

	<i>Final Written</i>		<i>Final Practical</i>	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
A&P II				
2019 (N=59) (I)	88.0*	9.22	90.0*	9.22
2021 (N=80) (FI)	81.0	9.22	84.0	10.72
<i>Note.</i> *Mean grades for the final written exam and final practical exam were significantly higher in 2019 when the course was (I) only compared to spring 2021 when the course was (FI)				

TABLE 6
COMPARISON OF WRITTEN/PRACTICAL UNIT EXAM GRADES IN A&P II IN SPRING 2019 AND SPRING 2021

	<i>Exam #1</i> <i>M SD</i>	<i>Exam #2</i> <i>M SD</i>	<i>Exam #3</i> <i>M SD</i>	<i>Exam #4</i> <i>M SD</i>	<i>Exam #5</i> <i>M SD</i>	<i>Exam #6</i> <i>M SD</i>
2019 (I) (N=59)	82.5(13.4)	73.0(14.6)	82.0(11.1)	81.5(9.6)	86.9(7.1)	84.2(8.3)
2021 (FI) (N=80)	88.0(8.7)*	77.0(18.3)	86.0(9.1)*	84.0(9.1)*	88.5(5.8)	88.0(8.0)*
<i>Note. Term = All unit exam scores represent means (SD),*Mean grades for unit exams 1,3,4 & 6 were significantly higher in spring 2021 compared to average unit exam grades in spring 2019.</i>						

Formative Assessments

Mean grades on all formative assessments were higher in spring 2021 when the course was (FI) compared to spring 2019 when the course was just (I). The mean of *all* formative assessments was significantly higher (92.3%) in 2021 when the (FI) model was implemented compared to 2019 when the course was only (I) (86.2%), $p = .00$. Mean grades on all formative assessments are shown in Table 7.

TABLE 7
COMPARISON OF FORMATIVE ASSESSMENTS IN A&P II IN SPRING 2019 AND SPRING 2021

<i>Spring 2019 (I)</i>		<i>Spring 2021 (FI)</i>	
Formative Assessments	Average	Formative Assessments	Average
Connect™ Assignments (25%)	86.0%	Connect™ Assignments (15%)	87.0%
Weekly Lab Assignments (15%)	85.6%	Interactive Lab Guidebooks (15%)	93.8%
		Pre-Class Content Work (10%)	96.2%
Mean All Formative Assessments	86.2%	Mean of All Formative Assessments	92.3%*

DISCUSSION

The current study was designed to evaluate and compare students’ performance and perceptions of two instructional approaches in A&P II, (FI) and (I). Within a comparable group of mostly first-year students in 2021, the (FI) approach appeared to have a strong positive effect on overall student performance and satisfaction. Although there is some variation of what comprises flipped learning, it is clear that its primary goal is for students to engage in some form of content prior to class time, thus allowing classroom time to focus on higher levels of Bloom’s Taxonomy including analysis, synthesis, and application through the engagement of more integrated and active learning (Anderson et al., 2001).

This study examined three research questions.

1. Did the positive student response to the (FI) instructional approach persist within A&P II over repeated offerings and during face-to-face instruction?
Students’ perceptions of the (FI) approach were uniformly and consistently positive. Many students suggested that the (FI) environment was effective, engaging, and motivating. The positive student perceptions in this semester-long face-to-face setting were quite consistent with those reported for a half-length semester of flipped online instruction during the pandemic (Peacock et al., 2022).
2. Did the (FI) instructional approach result in better performance compared to integration only, as measured in several ways?

Higher assessment scores were observed in 2021 on unit exams for all systems covered, and formative assessments for the (FI) students, as well as higher overall proportions of satisfactory grades, and shifts from the B and C range to the A level. Although the cumulative final written and practical exam grades were higher in 2019 when the course was integrated only, students' performance on unit exam grades and the formative assessments improved in 2021 when the (FI) instructional approach was implemented. Although the reason is unclear, students in the (FI) year seemed to struggle with the cumulative year-end assessment, but still scored in the B range. In the previous A&P I course, there are no cumulative year-end assessments, so this is students' first exposure to them.

3. What features of course design and delivery appeared to be most useful to students in the flipped+integrated instructional approach?

Students indicated that the PCW, which included viewing pre-recorded didactic presentations, with required note-taking assignments, prepared them to arrive in the group space prepared to have discussions and engage in integrated and active learning. Encountering the same material multiple times and in multiple forms led them to be more accountable and motivated, allowing them to consistently check their understanding of course concepts. Students also reported increased interest in the course topics in the (FI) year.

These findings are consistent with previous investigations reported in reviews. Galindo-Dominguez et al. (2021) analyzed 61 studies that included control groups and pre/post-test comparisons representing data from 5541 students. In the 19 higher education studies, both control and flipped groups improved their performance, somewhat more in the flipped group. They noted that the flipped method also increased learning motivation, autonomy, and self-regulation. These themes are reflected in the student comments presented here. Al-Samarraie et al. (2020) reviewed 85 studies in higher education, with 23 in the medical sciences, most of which showed significant positive effects of the flipped model on student learning as shown by improved exam scores, although other studies showed no difference between groups, or better performance in the traditional group, perhaps due to the extra work required in the flipped classroom. They noted that students may need to develop familiarity and confidence with flipped learning as they become more self-directed learners. Chen et al. (2017) reviewed 9 medical education studies with control groups and reported generally positive student perceptions of and preference for the flipped approach, but inconclusive effects of this method in improving knowledge and skills, relative to a traditional approach. In engineering education, Karabulut-Ilgu et al. (2018) reviewed 62 studies; the majority indicated that the flipped model was more effective in improving student performance, while only a few showed that the traditional model was more effective. Another analysis of 28 articles describing the use of the flipped model in health professions education showed performance effects and student preference in favor of the flipped model (Hew & Lo, 2018). They also noted increased effectiveness when quizzes were used to enhance student accountability for using the pre-class videos (Hew & Lo, 2018). Gilboy et al. (2015) assessed the perceptions of 142 students of the flipped approach in nutrition courses and reported that 76% of students preferred engaging in videos prior to class time to F2F lectures, 64% of students stated they would rather participate in active learning activities during F2F class time than listen to an instructor for an entire class period and 56% felt they learned how to use the material more effectively using the FL format. Not only did the majority of students prefer the flipped model but also noted that feedback indicated that it was important to gain student buy-in and to keep recorded lectures under 15 minutes in length. Welsh (2023) reported that a majority of adult learners in a pediatric nursing course preferred the flipped approach. First-year graduate students in a flipped physiology course had higher exam performance in the cardiovascular, respiratory, and renal area exams compared to traditional instruction (Tune et al., 2013). They attributed the improvement to the homework and in-class quizzes associated with the flipped model as motivating factors. In an A&P I course, the traditional face-to-face approach was compared to a hybrid flipped model. No differences were seen between the traditional and hybrid groups on summative exam scores, but evaluations of the hybrid classes were more positive. Course pass rates were higher in the hybrid sections (Jafar & Sittler, 2021). Yestrebsky (2015) showed performance improvements in college-level chemistry courses when the FL was implemented; more students earned A's and B's in the FL format compared to a

more traditional learning format. Interestingly, Jensen et al. (2015) have suggested that both the traditional and flipped modes of instruction show no differences in learning and satisfaction when both use an active learning constructivist approach. In our case, the integrated model by definition includes active learning and hands-on activities in every class, with the flipped approach being the variable in our comparison. Many of these studies stress that student accountability, in terms of quizzes, etc., is essential for motivating students to use the pre-class videos. We use required note-taking and Guidebook assignments to accomplish this as noted in the narrative comments.

Advantages of the Flipped Learning Model

The numerical and narrative perceptual responses gathered from students were predominantly positive, with the ability to prepare for classroom time through the PCW and having an understanding of course content prior to the in-class time noted most frequently. The FL promoted more in-class integration and active learning through hands-on laboratory activities and active learning opportunities. Many students noted that the PCW prepared them to deepen their understanding and knowledge of course content during classroom time. Previous studies have described students' perceptions when the FL approach was implemented and reported similar findings to those concluded in the current study. Galindo-Dominguez et al. (2021), also noted that the FL format in college-level courses is more effective than other instructional methodologies relative to student motivation, self-efficacy, and student engagement.

Additionally, the majority of students in the current study expressed that they were ready to learn and succeed when flipped learning was added to the integrated approach. Students found value in the PCW throughout the semester. Many students reported that they appreciated the format because they could come to class prepared and engage in more active learning. It was evident that many of the students were motivated and driven to do well in this class to feel confident for the upcoming exam. This relates to the assumption of adult learning that "adults are mostly driven by internal motivation, rather than external motivators" (Merriam & Bierema, 2014, p. 47). Students want to do well in A&P II but are ultimately internally motivated to be successful learners. The instructors also explained at the beginning of the semester that the purpose of the instruction approach and the (FI) was to help them feel confident synthesizing and using the material. "Adults need to know the reason for learning something" (Merriam & Bierema, 2014, p. 47), so this may increase student engagement.

The (FI) approach appears to enhance active learning more than just (I). The benefits of the (FI) approach allow students to remain engaged in active learning throughout the entire class time, constantly working towards a specific course objective through many hands-on activities, laboratory experiences, and group discussions. Mini-didactic sessions serve to reinforce the more complex mechanisms introduced in the PCW. Engaging in course content through PCW prior to class time resulted in fewer situations where students were passively taking notes and listening while the instructor was "lecturing". The student comments emphasized the value of the PCW relative to their learning of the bodily systems covered in A&P II. Flipped learning promotes more collaborative group work and integrated laboratory activities during class time. Further, adopting flipped learning into an already integrated course further enhances opportunities for active learning during class time.

We have some advantages in our ability to implement a FI approach. On our campus, all students and instructors are provided with iPads and Apple TV is available in the classroom. The classrooms are equipped with the Anatomage™ Table. Integration with the campus course management system also facilitates learning. Thus, across the campus, there is a good level of familiarity with technology. Some studies have indicated that technology issues, including access and familiarity, can be barriers to the success of the flipped model (Al-Samarraie et al., 2020; Galindo-Dominguez, 2021; Karabulut-Ilgü et al., 2018), but given our resources and the absence of technology complaints in the survey, we have implemented the flipped model successfully. Flipped learning is also used in other areas on our campus, including psychology and chemistry, which are included in our students' curriculums.

Challenges of the Flipped Learning Approach

One of the larger barriers to combining flipped learning with integrated is the bigger upfront time investment and familiarity with appropriate technology by instructors to make the videos and incorporate them into the course management system, although in subsequent years, these are easily revised and modified based on student and instructor feedback and assessment. There may continue to be student resistance to more active pedagogies and a lack of familiarity with and access to technology. As we have reported here, other studies also identified student difficulties in flipped courses with the length of video materials, student resistance, and lack of instructor feedback (Al-Samarraie et al., 2020; Galindo-Dominguez et al., 2021; Karabulut-Ilgü et al., 2010). The theme of comments related to the length of the PCW also appears in our data. One reason for this may relate to the inevitable increase in workload outside of classroom time. The expectation to engage in pre-class recordings and completing the note-taking template likely increases the time students spend in this course compared to other first-year college classes, which may contribute to these negative comments.

Strengths of the Current Study

A single supervising instructor created all the video modules managed all aspects of the course website, and oversaw all sections to ensure that there was consistency between the sections and instructors, with the same content expectations and assessments. The perceptual assessment was the same for all sections in both years (with the exception of added questions concerning the flipped model in 2021). It was offered to all students enrolled in the course and had response rates of 76% of the students in spring 2020 and 87% of the students in spring 2021. Thus, the results represent a high proportion of students in the course. In both semesters, exam grades made up 60% of the final grade with other assignments worth 40%. The “Other” category differed by the inclusion of PCW and interactive guidebooks in 2021. Exams were very similar or identical in the two years.

Limitations of the Current Study

There were differences in the demographics of the (I) and (FI) years, with different students in each year, more health sciences students in 2019, and many more females in 2021. This gender disparity is expected to increase with the addition of nursing students to the course in the future. A larger proportion of students returned to the perceptual survey in 2021, which could somewhat bias the results in either a positive or negative direction. There were small extra credit opportunities offered to students engaged in service learning in both 2019 and 2021, but the contribution of these to the grade was not available. During these two semesters, there was no pre/post content test done, although the comparison of quiz and exam grades allows performance comparisons. Pre/post-testing will be incorporated in the future.

CONCLUSION AND FUTURE RESEARCH

The (FI) approach worked well in A&P II, and it certainly can be applied to other health science and higher education courses. The findings of the current study suggest that with appropriate pedagogical content knowledge and technology and laboratory instructional resources, , combining flipped and integrated learning models in a gateway health science course like A&P can be effective and beneficial to student learning if students are invested in the instructional approach. Future research will analyze students’ performance and perceptions of the (FI) instructional approach when three additional bodily systems are added to the curriculum and with a larger enrollment due to the addition of nursing students. Flipped classrooms promote autonomy to help students develop self-efficacy, motivation, and confidence.

ACKNOWLEDGEMENTS

We wish to thank the students and faculty of the School of Nursing and Health Sciences and the College administration for their willingness to invest in and engage with new ways of teaching and learning, and to all faculty who contributed data from their courses.

REFERENCES

- Al-Samarraie, H., Shamsuddin, A., & Alzahrani, A.I. (2020). A flipped classroom model in higher education: A review of the evidence across disciplines. *Educational Technology Research & Development*, 68(3), 1017–1051.
- Anatomage Virtual Dissection Table™. (n.d.). Anatomage, Inc., Santa Clara CA. Retrieved from <https://anatomage.com/table/>
- Anderson, L.W., Krathwohl, D.R., & Bloom, B.S. (2001). *A taxonomy for learning, teaching, and assessing: A revision of Bloom's Taxonomy of educational objectives* (Complete ed.). Longman.
- Bergmann, J., & Sams, A. (2012). Flip your classroom. Reach every student in every class every day. In *International Society for Technology in Education* (pp. 120–190). Washington, DC.
- Chen, F., Lui, A.M., & Martinelli, S.M. (2017). A systematic review of the effectiveness of flipped classrooms in medical education. *Medical Education*, 51, 585–597.
- Finn, K., FitzPatrick, K., & Yan, Z. (2017) Integrating lecture and laboratory in health sciences courses improve student satisfaction and performance. *Journal of College Science Teaching*, 47(1), 66–75.
- Freeman, S., Eddy, S.L., McDonough, M., Smith, M.K., Okoroafor, N., Jordt, H., & Wenderoth, M.P. (2014). Active learning increases student performance in science, engineering, and mathematics. *Proceedings of the National Academy of Sciences*, 111(23), 8410–8415.
- Galindo-Dominguez, H. (2021). Flipped classroom in the educational system: Trend or effective pedagogical model compared to other methodologies. *Educational Technology and Society*, 24, 44–60.
- Gilboy, M.B., Heinerichs, S., & Pazzaglia, G. (2015) Enhancing student engagement using the flipped classroom. *Journal of Nutrition Education and Behavior*, 47(1),109–114.
- Henderson, C., Beach, A., & Finkelstein, N. (2011). Facilitating change in undergraduate STEM education practices: An analytic review of the literature. *Journal of Research in Science Teaching*, 48(8), 952–984.
- Hew, K.F. & Lo, C.K. (2018). Flipped classroom improves student learning in health professions education: A meta-analysis. *BMC Medical Education*, pp. 18–38.
- Jafar, S., & Sittler, V. (2021). Comparison of student outcomes in hybrid versus face-to-face A&P courses. *Journal of College Science Teaching*, 51(1), 58–66.
- Jensen, J.L., Kummer, T.A., & Godboy, P.D. (2015). Improvements from a flipped classroom may simply be the fruits of active learning. *CBE-Life Sciences Education*, 14, 1–12.
- Karabulut-Ilgu, A., Cherrez, N.J., & Jahren, C.T. (2018). A systematic review of research on the flipped learning model in engineering education. *British Journal of Educational Technology*, 49(3), 398–411.
- McLaughlin, J., Roth, M., Glatt, D., Gharkholonarehe, N., Davidson, C., Griffin, L., . . . Mumper, R. (2014). The flipped classroom: A course redesign to foster learning and engagement in a health professions school. *Academic Medicine*, 89(2), 236–243.
- Merriam, S.B., & Bierema, L.L. (2014). *Adult learning: Linking theory and practice*. Jossey-Bass.
- Pauk, W., & Owens, R. (2010). The Cornell System: Take Effective Notes. In *How to Study in College* (10th Ed., Chapter 10, pp. 235–277). Boston, MA: Wadsworth. ISBN 978-1-4390-8446-5.
- Peacock, J., FitzPatrick, K., & Finn, K. (2020). Integrating lecture and laboratory in A&P: Student perceptions and performance persists over three years. *Journal on Excellence in College Teaching*, 31(1), 90–103.
- Peacock, J., FitzPatrick, K., & Finn, K. (2022). Student performance and perceptions of the COVID-19 related midterm shift from face to face to online learning A&P course. *Journal on Excellence in College Teaching*, 33(1), 111–138.
- Seymour, E., Wiese, D.J, Hunter, A.-B., & Daffinrud, S. (2000). Creating a Better Mousetrap: On-line Student Assessment of Their Learning Gains. *National Meetings of American Chemical Society Symposium*. “Using Real-World Questions to Promote Active Learning”. San Francisco, CA.

- Strauss, A.L. (1987). *Qualitative Analysis for Social Scientists*. New York, NY: Cambridge University Press.
- Strauss, A.L., & Corbin, J.M. (1990). *Basics of qualitative research: Grounded theory procedures and techniques*. Newbury Park, CA: Sage Publications.
- Tune, J., Sturek, M., & Basile, D. (2013). Flipped classroom model improves graduate student performance in cardiovascular, respiratory, and renal physiology. *Advanced Physiology Education*, 37(4), 316–320.
- Welsh, A. (2023). *Flipped Classrooms: A Next Generation Nursing Case Study*. Scholarly Teacher. Retrieved March 15 from <https://www.scholarlyteacher.com/post/flipped-classrooms-a-next-generation-nursing-case-study>
- Yestrebky, C.L. (2015). Flipping the classroom in a large chemistry class-research university environment. *Procedia Social and Behavioral Sciences*, 191, 1113–1118.