Learning Anatomy & Physiology Virtually: Student Performance During COVID-19
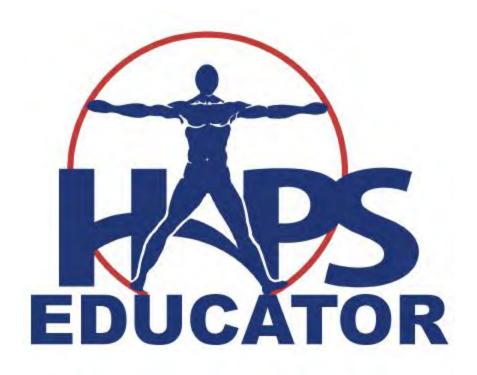
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Learning Anatomy & Physiology Virtually: Student Performance During COVID-19

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Abstract

Delivering Anatomy & Physiology (A&P) labs online became necessary in the spring of 2020 due to the COVID-19 pandemic. For four semesters (Summer 2020 through Summer 2021), our A&P1 and A&P2 labs were instructed in a virtual format. Each lab session included a one-hour synchronous session led by teaching assistants followed by at-home lab activities performed independently by students. Formative lab practice assignments were provided, and summative lab assessments were conducted weekly. Student performance in these online A&P1 labs was similar to performance during in-person labs, although more students failed or withdrew from the combined A&P1 lecture and lab course in the online environment compared to in-person. A&P2 performance data were very similar online versus in-person for both the A&P2 lab and the combined A&P2 lecture and lab course. Overall, our experience supports the conclusion that course modality is not the central factor in determining student success. http://doi.org/10.21692/haps.2022.008

Key words: anatomy and physiology, attrition rate, online, student success

Introduction

In March 2020, the global COVID-19 pandemic necessitated a shift to virtual courses. At Georgia State University, a two-week spring break in 2020 was followed by a pivot to virtual platforms for the remainder of the Spring 2020 semester. The need for a sudden and immediate shift to online courses was a topic of frequent conversation in HAPS discussion groups and town halls, as instructors and institutions came up with different plans to structure and implement new online courses. Access to these town halls and conversations with other HAPS members who had prior experience teaching A&P online was invaluable in helping us start planning our own online A&P labs. We have previously described our process in designing the framework for online Anatomy & Physiology (A&P) labs implemented in Summer 2020 (Ediger and Rockwell 2020). In total, these lab courses were offered each semester from Summer 2020 through Summer 2021, as we returned to in-person, on-campus instruction in Fall 2021. This article describes student performance in online A&P labs over these four semesters.

The A&P1 and A&P2 courses described here form a two-semester sequence, delivered as a combination lectures and laboratory sessions. The lecture component was virtual, with asynchronous lecture recordings provided in Summer 2020 and Fall 2020. In Spring 2021, lecture sessions were also virtual, but synchronous, and this continued in Summer 2021. Typically, there were four to eight lab sections that met together as one lecture, with the exception of the Fall 2020 semester in which all A&P1 or A&P2 students were combined together into a single A&P1 or A&P2 section for the asynchronous online lectures. The lecture portion of the course comprised 70% of the final course grade, while the lab portion provided the remaining 30%. Each semester, extra-credit opportunities in either lecture, lab, or both and worth a maximum of 1% were provided during the course. A&P1 and A&P2 courses were graded on an ABCDF scale, with C being the lowest passing grade, and a 70% course average the minimum for earning a C.

These A&P courses are cataloged at the 2000-level and are pre-requisites for application to an undergraduate nursing program. Historically, approximately 40% of our A&P students have been classified as "pre-nursing" students. These A&P courses also attract students from majors such as biology and chemistry as well as students who have previously completed an undergraduate degree but are interested in pursuing a health care career.

A&P courses have a reputation for being content-rich, strenuous courses with large numbers of students who earn a grade of D or F or withdraw. This percentage is also known as the "DFW rate," or the course attrition rate, as it represents students who cannot move on in their course sequence. In 2016, Russell and colleagues conducted a literature review of reports that included A&P1 DFW rates and reported a wide range of DFW rates, from 29 to 62%. They also provided data from several years of A&P1 at Jamestown Community College, showing a DFW rate of 41.6% (Russell et al. 2016).

Awareness of potentially high DFW rates, coupled with the fear of losing contact with our students in an online environment, shaped our course design decisions. Our first goal in considering how to design our online A&P lab courses

was to maintain content coverage to prepare students for future careers in health care. A second objective was to create opportunities for student engagement, to the best of our ability, given the circumstances. During this time, students did not have the option on our campus to choose between in-person versus online coursework. The only option for students was to take online courses, and many students would be new to this process. Encouraging student engagement, then, was an essential element of our approach to mitigate the various circumstances of the online student experience during the pandemic period.

The structure that we chose for our online A&P labs included a synchronous, one-hour virtual session led by a graduate teaching assistant (TA), coupled with at-home lab activities that students completed independently. Lab activities were designed specifically for each week's topic, referencing our custom (in-house) lab manual, and making use of online anatomy and histology atlases, virtual physiology explorations, as well as a lab supply kit that students purchased from a third-party supplier. For each lab, there was a written portion for students to submit online to be graded for accuracy by the TA. After grading, assignments were available for students to review online.

Formative assessments were provided in the form of online lab practice assignments delivered through the textbook website. Lab practice assignments contained questions similar to questions on the summative assessments. Multiple attempts were available; each attempt contained half as many questions as a summative assessment. Summative assessments took the form of weekly lab assessments that students completed at home with a lockdown browser and recorded video proctoring.

This framework provided the basis for our lab structure during all four semesters of our online A&P labs. Labs met weekly online during the fall and spring semesters, and twice weekly during summer semesters. Required attendance at weekly virtual lab sessions was the cornerstone of our online lab experience, providing students an opportunity for instruction, guidance on the lab activity, an opportunity to ask questions, and to see other students and the TA. As a supplemental form of instruction, lab videos produced for the course were also provided through our learning management system (LMS). Each lab section had a maximum enrollment of 24 students, and was led by one TA, typically a master's student in biology, medical science, occupational therapy, physical therapy, or health policy programs. TAs received weekly training at preparatory meetings in advance of the weekly lab session.

In the A&P1 in-person lab course, there were 3 lab exams, one for each unit. The in-person A&P2 lab course had 2 lab exams, covering the first or second half of the course. Online A&P1 and A&P2 lab courses switched to a weekly assessment strategy, where students completed shorter, more frequent assessments. Regardless of the testing framework, the

grading category for lab exams or weekly lab assessments counted for half of the lab grade, or 15% of the final course grade.

The summer semester consisted of a 7-week term; there were seven lab assessments in Summer 2020. In Summer 2021, the lab had only six weekly lab assessments due to the timing of the July 4th holiday. In fall or spring semesters, the course had 13 or 14 weekly lab assessments. Students were allowed two attempts for each weekly lab assessment online. During the fall or spring semesters, the lowest score for a weekly lab assessment was dropped at the end of the semester.

Summer 2020 and Fall 2020 had the same structure, which is described in our previous article (Ediger and Rockwell 2020). After Fall 2020, we made some adjustments to the lab structure for Spring and Summer 2021. For example, after Fall 2020, we changed the timing of introducing new topics and assessing students. In Fall 2020, the TA-led lab session consisted of a "review/preview" format. The first 30 minutes was dedicated to reviewing the content of the lab activity that students had just submitted for grading and preparing for the upcoming lab assessment. The second half of the session previewed the next lab activity that students would complete after the lab session. Our intention in originally choosing this timing was to allow students to ask questions about what they had just completed before being quizzed over that topic.

However, it proved to be too confusing to keep track of review topics versus new topics, and TAs observed that the review didn't function as such, because students hadn't studied enough for it to be a review. For Spring 2021, we simplified the timing, and kept each lab session focused on only one lab topic. Students joined the lab session for instruction about that one topic, as well as tips for completing the lab activity. The lab activity was submitted within 48 hours after the lab session, as before, and then that weekend's lab assessment covered that same lab topic. This structure had the downside of testing students over the lab activity topic before they had received feedback on the lab activity itself. To mitigate this, students were encouraged to reach out to their TAs if they had any questions while completing the lab activities, and TAs were also encouraged to communicate with students via email if they noticed generalized misconceptions while grading lab activities.

The second change in our lab structure between Fall 2020 and Spring 2021 related to the nature of the prelab homework that was assigned. In the custom lab manual that students are required to purchase for the course, we included "PreLab" pages for each lab module. For Fall and Summer 2020, the prelab homework consisted of completing these prelab pages and submitting them prior to the lab session for grading by the TA. This meant that TAs were devoting a lot of time to grading, as they graded both prelab homework and lab activities submitted after lab. In addition to the lab manual, we had also created a library of lab videos for the course.

In Spring 2021, we assigned prelab homework of watching the lab videos and answering associated multiple-choice questions through our LMS. Because labs occur at various times throughout the week, the lab video homework was open on the LMS during the entire week, and some students chose to complete the prelab homework after their lab session. In retrospect, we could have avoided this by setting a due date at the beginning of each week.

We also attempted to encourage preparation for and participation in the lab sessions by implementing in-class quizzing starting in Spring 2021. These questions were either "warm-up" style questions based on the prelab homework completed outside of lab (Spring 2021) or embedded "are you paying attention to what we just covered" participation questions (Summer 2021). To include this category in our grading framework, we converted the online lab practice assignments to an extra-credit opportunity, as one part of the 1% extra-credit possible that semester. Graded categories that determined the Lab Grade (which constituted 30% of the course grade) for each semester of our online lab are shown in Table 1. Comparison with our in-person lab can be found in our previous article (Ediger and Rockwell 2020).

Methods

Student Performance in A&P Courses

Student performance data for each course were exported from the university repository of these data. Data exported included the total numbers of students who ended the course with grades of A, B, C, D, F, or W (for withdrawn). There is also a category of "O" for Other. The percentage of students achieving each letter grade was calculated using Excel. The category of "O", which was valued between 0 and 7 students each semester, was omitted from this analysis.

Fall 2018 represented the first semester that the A&P1 lab was based on our in-house custom lab manual; Spring 2019 was the first semester this custom lab manual was used in A&P2. For this reason, Tables 2 and 4 begin at Fall 2018, but Tables 3 and 5 start with Spring 2019.

Student Performance in A&P Labs

Numeric grade data were exported from the LMS course gradebook for each individual A&P1 or A&P2 lecture (and associated labs) course for all semesters. For A&P1 this analysis was conducted from Fall 2018 through Fall 2021; for A&P2, the analysis began at Spring 2019. After exporting the course gradebook to Excel, individual student records for each semester were combined, and the course grade, lab grade, and lab exam (or weekly lab assessment) averages were calculated for the entire group of students. In each semester, there were one to three different lecture instructors; these students were merged into one group for A&P1 or for A&P2 each semester. Lab sections have a maximum enrollment of 24 students per section. Comparisons described in the Results are descriptive in nature; student numbers and course to course variabilities do not support meaningful statistical evaluation.

The total number of students in the LMS course roster were compared with the total number of students reported in the university's course performance data platform. The correlation was imperfect; for some semesters, the numbers matched exactly, but for other semesters the LMS contained between one and eight additional student records. For Fall and Spring semesters, the larger student enrollment yielded a discrepancy of 3% or less; in the Summer (smaller total student body), a small discrepancy had a larger effect, with the largest effect of an additional five student records in the A&P2 course of Summer 2019 causing a discrepancy of 8%. Small discrepancies between the number of students expected and the number of student records that remain in the gradebook suggest that the removal process is imprecise.

Summer 2020	Fall 2020	Spring 2021	Summer 2021
15% - weekly lab assessments	15% - weekly lab assessments	15% - weekly lab assessments	15% - weekly lab assessments
10% - lab activities	10% - lab activities	10% - lab activities	10% - lab activities
2.5% - prelab homework pages from lab manual	2.5% - prelab homework pages from lab manual	2.5% - lab video homework questions	2.5% - lab video homework questions
2.5% - online lab practice assignments	2.5% - online lab practice assignments	2.5% - in-class quiz	2.5% - in-class quiz

Table 1. *Grading schema for online A&P labs*

Results
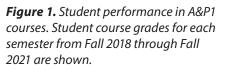
Student Performance in A&P Courses: DFW Rates and Grade Distributions

Student letter grades in A&P1 and A&P2 courses, from A to F, W for withdrawal, and the combined DFW rate are presented in Tables 2 and 3 for A&P1 and A&P2 courses, respectively. Student letter grades are also presented graphically in Figures 1 and 2. The course modality for each semester, either in-person, online, or pivot to online, is indicated next to the date of the semester.

Figure 1. *Student performance in A&P1 courses. Student course grades for each semester from Fall 2018 through Fall 2021 are shown.*

Semester (Modality)	A	B	C	D	F	W	DFW	Enrollment
Fall 2018 (I)	22%	29%	23%	6%	10%	10%	26%	586
Spring 2019 (I)	20%	32%	19%	9%	10%	10%	29%	404
Summer 2019 (I)	27%	32%	16%	7%	9%	8%	25%	121
Fall 2019 (I)	14%	26%	32%	11%	11%	6%	28%	527
Spring 2020 (P)	*15%*	*28%*	*28%*	*7%*	*8%*	*15%*	*29%*	*371*
Summer 2020 (O)	**21%**	**23%**	**20%**	**6%**	**11%**	**19%**	**36%**	**159**
Fall 2020 (O)	**16%**	**22%**	**19%**	**6%**	**10%**	**27%**	**43%**	**580**
Spring 2021 (O)	**14%**	**18%**	**22%**	**14%**	**19%**	**13%**	**46%**	**412**
Summer 2021 (O)	**17%**	**21%**	**20%**	**13%**	**11%**	**17%**	**41%**	**126**
Fall 2021 (I)	12%	25%	25%	13%	17%	9%	38%	513

The Instruction Modality each semester was either I (In-person), O (Online), or P (Pivot to online).

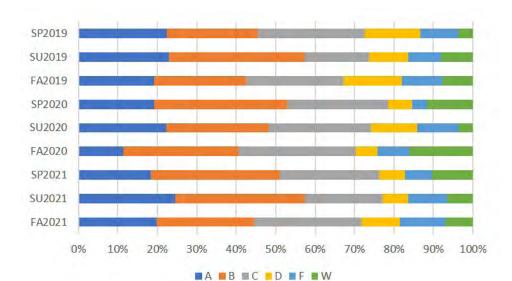**Table 2.** *Student performance in A&P1 course*

Figure 2. *Student performance in A&P2 courses. Student course grades for each semester from Spring 2019 through Fall 2021 are shown.*

Semester (Modality)	A	B	C	D	F	W	DFW	Enrollment
Spring 2019 (I)	22%	23%	27%	14%	9%	4%	27%	369
Summer 2019 (I)	23%	34%	16%	10%	8%	8%	26%	61
Fall 2019 (I)	19%	23%	25%	15%	10%	8%	33%	244
Spring 2020 (P)	*19%*	*34%*	*26%*	*6%*	*4%*	*12%*	*22%*	*344*
Summer 2020 (O)	**22%**	**26%**	**26%**	**12%**	**11%**	**4%**	**26%**	**85**
Fall 2020 (O)	**11%**	**29%**	**30%**	**5%**	**8%**	**16%**	**30%**	**273**
Spring 2021 (O)	**18%**	**33%**	**25%**	**6%**	**7%**	**10%**	**24%**	**325**
Summer 2021 (O)	**25%**	**33%**	**20%**	**7%**	**10%**	**7%**	**23%**	**61**
Fall 2021 (I)	20%	25%	27%	10%	11%	7%	28%	227

The Instruction Modality each semester was either I (In-person), O (Online), or P (Pivot to online).

Table 3. *Student performance in A&P2 Course*

For A&P1, in-person DFW rates prior to the pandemic ranged from 25-29%. In our online course, DFW rates ranged from 36-46%, with the highest DFW rate of 46% occurring in Spring 2021. The percentage of students withdrawing from the course ranged from 6-10% before Spring 2020; this percentage was 13-27% for our online A&P1 courses, Summer 2020 through Summer 2021. The DFW rate was 43% in Fall 2020 and 46% in Spring 2021. Between Fall 2020 and Spring 2021, the W% dropped from 27% to 13%, but the F% increased from 10% to 19%.

For A&P2, in-person DFW rates before Spring 2020 ranged from 26-33%. In the online A&P2 course, DFW rates ranged from 23-30%. The percentage of students withdrawing from the course ranged from 4-8% before Spring 2020; this percentage was 7-16% in online A&P2 courses.

Student Performance in A&P Labs: Lab Grade Distributions

Student grade averages generated from LMS gradebook data are shown in Tables 4 and 5, for A&P1 and A&P2 respectively. Grades are shown as % grade averages for the entire course, for the 30% portion of the lab only, and for the lab exam or lab assessment gradebook category. These data represent students who earned an A, B, C, D, or F in the course. Students who received a grade of W for the course are not included, because they are routinely removed from the LMS roster when registration data updates.

Semester (Modality)	Grade Averages			No. of Students
	Entire Course	Lab Portion	Lab Exams*	
Fall 2018 (I)	77%	73%	65%	534
Spring 2019 (I)	77%	72%	66%	368
Summer 2019 (I)	75%	73%	69%	116
Fall 2019 (I)	73%	72%	62%	504
Spring 2020 (P)	*76%*	*71%*	*63%*	*322*
Summer 2020 (O)	**74%**	**70%**	**62%**	**136**
Fall 2020 (O)	**75%**	**72%**	**67%**	**430**
Spring 2021 (O)	**68%**	**71%**	**65%**	**368**
Summer 2021 (O)	**73%**	**73%**	**65%**	**108**
Fall 2021 (I)	71%	66%	60%	478

*Lab Exams were either lab practical exams, or weekly Lab Assessments (from Summer 2020 onwards).

Table 4. *Student Performance in A&P1 Lab Courses and Lab Exams*

Semester (Modality)	Grade Averages			No. of Students
	Entire Course	Lab Portion	Lab Exams*	
Spring 2019 (I)	76%	72%	67%	360
Summer 2019 (I)	73%	70%	63%	61
Fall 2019 (I)	75%	73%	67%	233
Spring 2020 (P)	*78%*	*77%*	*66%*	*311*
Summer 2020 (O)	**74%**	**71%**	**62%**	**83**
Fall 2020 (O)	**75%**	**72%**	**67%**	**232**
Spring 2021 (O)	**76%**	**79%**	**75%**	**297**
Summer 2021 (O)	**77%**	**77%**	**69%**	**58**
Fall 2021 (I)	76%	73%	69%	211

*Lab Exams were either lab practical exams, or weekly Lab Assessments (from Summer 2020 onwards).

Table 5. *Student Performance in A&P2 Lab Courses and Lab Exams*

In the A&P1 lab, before Spring 2020, lab grade averages were consistently 72 or 73%. This continued in the online environment, with lab grade averages of 70-73% from Summer 2020 through Summer 2021. In A&P2, lab grades before Spring 2020 were very similar to A&P1 lab grades, with a range of 70-73%. In the online environment, lab grades matched these scores or increased, with a highest average of 79% in Spring 2021.

Student Performance in A&P Labs: Comparison of Lab Exams versus Weekly Lab Assessments

In Tables 4 and 5, the Lab Exam column represents either the averages of lab exams or weekly lab assessments. For the A&P1 lab in-person, lab exam averages ranged from 62-69%. In the online lab course, weekly lab assessment averages ranged from 62-67%. For A&P2, in-person lab exam scores averaged between 63-67%; online, A&P2 weekly lab assessment scores averaged from 62-75%.

As we returned to an on-campus lab experience in Fall 2021, we chose to continue the weekly lab assessment testing system. In the on-campus lab, students have only one attempt to complete the weekly lab assessment during the lab itself, with TA proctoring. For Fall 2021, we chose to drop the lowest two weekly lab assessments, partly as a concession to the continued stress of the COVID-19 pandemic and the challenges faced by faculty, staff, and students returning to campus. The weekly lab assessment average for the A&P1 lab in Fall 2021 was only 60%; the A&P2 lab had a weekly lab assessment average of 69%, similar to the lab exam and lab assessment averages of previous semesters.

Discussion

The DFW rates in our A&P1 course suggest that students were not as successful in the online environment as they typically are in an in-person course when there is no pandemic. Our DFW rates of 43 and 45% for Fall 2020 and Spring 2021 were higher than the DFW rate of 25-29% seen before Spring 2020. It appears that the higher DFW rate for the A&P1 course in Fall 2020 was largely due to the increase in students withdrawing from the course, with a 27% W rate that semester. In Fall 2020, we had an extended deadline for students to withdraw from courses, which may have affected the W rate that semester. However, Fall 2020 was also the first semester that taking an online course was required for any student intent on taking college classes at our campus. Students did not have another option, and this may have been the first online course experience for many students. A&P1 in Summer 2020 was also online, as we began to offer only online courses that summer, but our summer enrollment is much smaller than fall or spring, and summer courses occur at twice the pace, yielding a different, more intense experience.

Although we attempted to stress to students enrolling in online A&P courses in Fall 2020 that these would be rigorous courses, students may have been under the false impression that the A&P1 course would be easier because of the online modality. Communication with students revealed that some students were surprised to find that attendance at synchronous virtual lab sessions was required. Other students reported being overcommitted and stressed for time, having registered for 18 credit hours of online coursework without appropriate estimations of the amount of time required to complete the workload for each course. In addition, with most courses structured within an asynchronous framework, students were able to register for a full course load while also working full-time and/or performing caregiving duties at home. This created stress for students who did not realistically have enough time to complete their coursework. For some, this may have been compounded by additional challenges within their home environments for a variety of practical, logistical, and/or technical reasons.

In Spring 2021, we expected the course to be more successful, as the student body was now in its second semester of online coursework. What we saw in A&P1 was a DFW rate that appeared to increase slightly, although the percentage of students withdrawing from the course declined to near normal levels. Looking at the course grade data, we saw that the course average for A&P1 in Fall 2020 was only 68%; this was the only semester for which the course average was below 70% (minimum passing grade). According to the grade distribution data shown in Table 2, the percentage of students earning a grade of F in A&P1 during the Spring 2021 semester was 19%, an important factor driving the course grade average down. Anecdotally, students reported that they wished to withdraw from the course, but they had already reached the maximum number of "W" courses for their academic careers, suggesting that students who would have withdrawn from the course were still on the roster but not attempting successful completion of the course.

The A&P2 course has the advantage of requiring successful completion of A&P1 as a pre-requisite. A&P2 course grade data and lab grade data showed student performance that was very similar in the online versus in-person course modality. Data for successful completion of A&P2 during our return to campus in Fall 2021 was similar to other semesters. Interestingly, Adams and Dewsbury (2021) recently reported a shift in student perceptions occurring between the first and second course in a two-semester A&P sequence. Perhaps we are seeing the results of a similar shift in student perception that increases student success in A&P2 compared to A&P1.

The weekly lab assessment average scores in the A&P2 lab are especially encouraging. During the pandemic, we invested in developing a question bank which was used to randomly generate questions for lab practice assignments. These assignments were available each semester; students had multiple attempts to complete these lab practice assignments, which mirror the weekly lab assessments in content and question structure. The 75% weekly lab assessment average seen in A&P2 in Spring 2021 may be an anomaly; alternatively, it may indicate that with appropriate practice, students can be more successful on these summative assessments. Investing in providing multiple opportunities for students to practice ahead of the summative assessment is useful for the course overall.

Several limitations must be kept in mind when comparing performance data from one semester to another. This data set does not represent data from a controlled environment where only one variable is manipulated. From one semester to the next, we often had different lecture instructors, with up to three individuals teaching different sections of an A&P1 or A&P2 lecture in a given semester. When we moved to virtual labs, we chose to not continue with large summative lab practical exams, partly because we hoped that regular, smaller summative lab assessments would enhance student learning. As a result, comparing in-person lab exams to online lab assessments was an imperfect comparison. Finally, additional tweaking between Fall 2020 and Spring 2021 resulted in changes to the flow of lab content and assessments, although the basic framework of a required 60-minute synchronous virtual meeting between TAs and students was unchanged.

There are a wide variety of online experiences created for science labs and there does not appear to be consensus about best practices and/or outcomes (Brinson 2017, Faulconer and Gruss 2018). In some instances, science labs were shown to be successful with virtual or hybrid approaches compared to fully face-to-face (Massey et al. 2021; Faulconer and Gruss 2018; Grønlien et al. 2021). However, there are also reports of students being less successful in virtual formats (Brown and Peterson 2021; Romeo et al. 2021).

The Brown and Peterson (2021) study is especially interesting because all students enrolled in the same asynchronous A&P1 lecture and then they chose either a face-to-face or an online A&P1 lab, each of which involved the same lab activities and all the same assessments. In this 101-student A&P1 course, the face-to-face group had a better passing rate, higher course grade average, and lower withdrawal rate compared to the group of students taking the asynchronous online lab, suggesting that completing the lab activities in the lab room itself correlated with improved student outcomes. It is tempting to wonder if there was also a student factor driving the choice of an asynchronous, virtual versus a scheduled, in-person lab in this study, perhaps related to student motivation or the ability to stay on task during an online activity.

Brown and Peterson (2021) suggested that the key difference in the student lab experience was access to models and a cadaver pro-section, which enabled students to develop three-dimensional knowledge of anatomical structures through kinesthetic learning. In 2017, Van Nuland found

that handling a physical skeleton yielded improved learning compared to accessing a virtual anatomy tool. Interestingly, Faulconer and Gruss (2018) noted that the use of remote lab kits can create a blend between traditional labs focused on providing hands-on activities and purely virtual, online labs. In our virtual lab structure, we built in as much hands-on experience as possible by asking students to purchase a lab supply kit with dissection specimens, in addition to utilizing online textbook resources and a 3D anatomy app.

The experience of teaching and learning during a pandemic has undoubtedly affected student performance, student satisfaction with learning, and student stress in general. Living in lockdown amidst the toll and risks of COVID-19 for human health has created a stressful teaching and learning environment. Goyal and colleagues (2022) reported that chemistry students at Xavier University were less engaged in the summer of 2020, had difficulty adapting to online education, and experienced various social, emotional, and economic stresses. It will surprise no one that students have reported increased day-to-day difficulties as well as mental health challenges (Goyal et al. 2022; Kecojevic et al. 2020). In one survey, students enrolled in General Chemistry ranked "distractions at home" as more difficult on a Likert scale than successfully completing the course (Villanueva et al. 2020). We must expect that there have been educational costs due to the pandemic. As one example, a survey of seven economics courses taught in the spring of 2020 found that average assessment scores declined by 0.2 standard deviations (Orlov et al. 2021). Furthermore, an analysis of the performance of general chemistry students noted higher W rates in the spring of 2020 (Villaneuva et al. 2020). A complete picture of the effect of COVID-19 on education is yet to come.

In the midst of these pandemic-related challenges, many instructors have found ways to keep engaged with students. The chemistry instructors at Georgia Gwinnett College shared our concerns about losing student engagement in the pivot to online instruction in the spring of 2020, which led them to incorporate specific active learning strategies such as breakout sessions, polling, and small group projects (Villaneuva et al. 2020). The survey of economics courses also reported a wide variety in educational impact, that varied according to instructor experience teaching online, and usage of active learning strategies such as small group activities and projects (Orlov et al. 2021).

A survey of 10,092 higher education students from 10 countries across 4 continents during the pandemic's first wave identified the "teacher's active role" as one of three major factors influencing the quality of online learning (Keržič et al. 2021), which can be affirming to those of us seeking to reach students through online education. An interesting by-product of the recent mandatory online lab experience is an anecdotal increase in student appreciation for hands-on lab experiences, which has been discussed in HAPS town halls. This has also been noted in a recent report that students in

an online cadaver-based anatomy lab had similar test scores but lower confidence and satisfaction with virtual learning, especially because they could not learn from the cadaver in person (Wilhelm et al. 2022).

In summary, our experience of online A&P labs suggests that it is possible to maintain content coverage, a minimal level of student engagement, and provide students with an opportunity to successfully complete the course and progress in their pathway to a career in health care. Although our data are promising, they should still be viewed through a "pandemic lens", understanding that students and faculty were operating in an abnormally stressful environment and may not have been prepared for online instruction and learning. Online courses require personal initiative and accountability which makes online coursework a good fit for a specific type of student with a high level of intrinsic motivation. These data represent the experiences of a large group of students who may or may not have chosen to take online courses, if online course delivery was one option rather than the only option. Our experience also supports the findings of others who have reported that the modality of instruction, either in-person or online, is not the biggest factor in determining student performance (Attardi et al. 2018; Biel and Brame 2016).

Earning an A or B in A&P courses is an important step in progression toward a career in health care. Although the specific requirements for different health care programs vary, success in A&P makes a student a more competitive candidate for entry into a professional program and provides a strong foundation of knowledge of human body function upon which to build. Anecdotally, faculty instructors are still receiving grateful emails from students who have entered professional programs, such as nursing, physiotherapy or medical education. While it may feel as though there are fewer of these students who have been able to progress during the pandemic, our data suggest that regardless of delivery method, there were still many students who were successful in the courses and are now prepared to continue their pursuit of a career in health care.

About the Author

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