Online versus In-Person Instruction in a Laboratory-Based Animal and Veterinary Science Course

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Abstract

Online educational modalities are used extensively in courses that do not require hands-on laboratory experiences. However, due to the COVID-19 pandemic, there has been a need for transition from in-person to online laboratory-based courses, especially in animal and veterinary science courses. This study evaluated 163 undergraduate students enrolled in an introductory animal and veterinary science laboratory in the fall 2020 semester. Using surveys throughout the semester, student responses were collected and evaluated. Results indicated student performance on quizzes and exams were better during online instruction compared with in-person instruction, which contradicted previous studies reported in the literature. As a majority of these students were first-year, first-semester students, their metacognitive abilities were likely not fully developed. This laboratory course was taught initially online for the first half of the semester and then transitioned to in-person instruction as the university public health regulations allowed. Socially shared metacognitive regulation was only exercised during the in-person portion of the class. Results indicate an animal and veterinary science laboratory can successfully be taught online.

Keywords: animal and veterinary science, education, hybrid instruction, online instruction, online laboratory

Online teaching and learning have been rapidly integrated into educational environments across all disciplines over the past two decades (Oliver, 1999; Gallagher, 2019; Gallagher and Palmer, 2020). While this transition has been occurring in university level courses in years previous, the integration of traditionally hands-on courses has been a struggle for instructors and students (Wingo et al., 2017; Gallagher, 2019; Wang and Wang, 2021). The 2019 COVID-19 pandemic hastened the urgency for online integration and decreased total undergraduate student enrollment across all course types (Gallagher and Palmer, 2020; National Student Clearinghouse Research, 2021). While consumer demand, awareness, and acceptance of online education have been steadily increasing, business, health, education, and computer science are the most common online programs offered, likely because there is seamless transition between in-person and virtual instruction (Pellas and Kazanidis, 2015; Gallagher, 2019). These programs account for 60 percent of the exclusively online programs offered in the United States (Gallagher, 2019). However, educational institutions have struggled to meet online needs in science-based courses (Gallagher 2019; Gallagher and Palmer, 2020). Laboratory-based courses are more difficult to teach online due to their reliance on hands-on instruction and learning and are among the least common courses to be offered in an online format (Gallagher, 2019). Due to the need for peer collaboration in laboratory-based courses, students have a significant loss of social and intellectual connection in online courses (Meyers, 2008; Pellas and Kazanidis, 2015; Wang and Wang, 2021). As a result of the COVID-19 pandemic, laboratory-based courses experienced the most rapid transition from traditional, hands-on instruction to virtual experiences. Synchronous versus asynchronous instruction impacts the quality and perception of learning in virtual classes (Wang and Wang,

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2021). Synchronous instruction is better suited for social connection and learning (Wang and Wang, 2021). However, studies indicate asynchronous instruction creates a stronger intellectual connection with the material (Wang and Wang, 2021). The impact of a global pandemic on pedagogy and learning in science is difficult to measure; thus, the current study was conducted (Gallagher, 2019). With such abrupt transition from in-person to online instruction, the quality, depth, and integrity of traditional instruction needs to be examined.

Historically, it has been assumed that online classes are comparable with traditionally taught classes (Meyers, 2008; Pellas and Kazanidis, 2015; Wang and Wang, 2021). However, this assumption may only apply to the majority of degree programs that do not involve laboratory-based education (i.e., those that have already transitioned to an online format) (Gallagher, 2019; McGraw, 2020; Wang and Wang, 2021). The benefits of online educational programs include providing wider access for a greater variety of students and reducing the cost of traditional instruction by using computer supported collaborative learning approaches (Oliver, 1999; Iiskala et al., 2015; McGraw, 2020; Wallis, 2020). Increased meeting time flexibility, learning and teaching tools, as well as new opportunities with course design are desirable benefits of providing an online option (Oliver, 1999; Pellas and Kazanidis, 2015; Wallis, 2020; Wang and Wang, 2021). A knowledge gap exists on the efficacy of online instruction for laboratory-based science classes (Pellas and Kazanidis, 2015; Wang and Wang, 2021). In this case, the question arises regarding quality in classes taught completely online versus a blended format (Baleni, 2015; Pellas and Kazanidis, 2015; Wang and Wang, 2021).

Student perception and metacognition are parameters that can be used to measure quality of virtual laboratory-based science classes (Stanton et al., 2015; Wingo et al., 2017; Avargil et al., 2018; McGraw, 2020). Metacognition, as defined by Avargil et al. (2018), is the awareness of and reflection upon a person's cognitive processes (Jacobs and Paris, 1987; Stephanou and Mpiontini, 2017). Jacobs and Paris (1987) reported metacognitive knowledge and metacognitive regulation are two methods of evaluating student performance (Stanton et al., 2015; Stephanou and Mpiontini, 2017; Avargil et al., 2018). Metacognitive knowledge is defined as student awareness of what they know in relation to what they need to study (Jacobs and Paris, 1987; Stanton et al., 2015; Stephanou and Mpiontini, 2017; Avargil et al., 2018). This is considered the process where students think about thinking (Stephanou and Mpiontini, 2017; Avargil et al., 2018). Metacognitive regulation is defined as the actions students take to learn and control their personal performance (Jacobs and Paris, 1987; Stanton et al., 2015; Stephanou and Mpiontini, 2017). While metacognition is not the only factor involved in student performance, it has a large impact on scientific literacy and life-long learning in science education (Stephanou and Mpiontini, 2017; Avargil et al., 2018). Often, students feel that online courses are less important and consequently, are commonly ignored (McGraw 2020; Wang and Wang, 2021). Students in online courses spend more time off-task, have less engagement in active learning strategies and interact less with their instructor and peers (Pellas and Kazanidis, 2015; Wang and Wang, 2021). Problems with online courses increase with technical issues, feelings of isolation, a lack of previous online learning experience and a difference in student expectations for the course compared with previous instructional background (Pellas and Kazanidis, 2015). As a result, student perception of a completely online course or blended course format can be impacted negatively (Pellas and Kazanidis, 2015). The other perception commonly noted by students is that online courses are more difficult than those taught in-person for the same reasons listed above (Pellas and Kazanidis, 2015; McGraw, 2020).

Blended learning could offer a potential solution, especially in the sciences, for classes to transition to a partial online format (Baleni, 2015; Pellas and Kazanidis, 2015). To address whether an introductory animal and veterinary science laboratory course could be taught virtually, this study was designed to explore the relationships between student perception and quality of the course via student questionnaires and class performance. The objective of this study was to determine if student perception and performance in an introductory animal and veterinary science laboratory-based course would change depending on online versus in-person instruction.

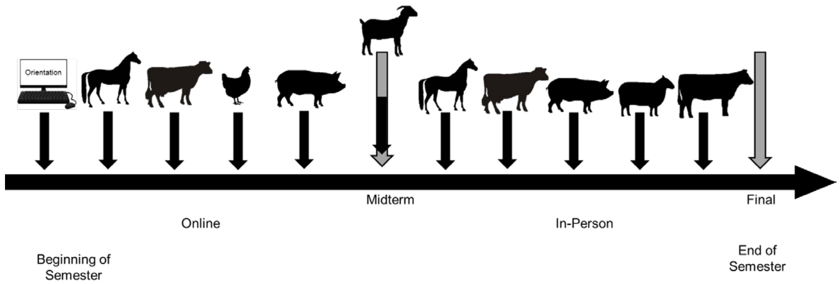
Methods

All experimental procedures and protocols were approved and deemed exempt by the Clemson University Institutional Review Board, and all participants provided written, informed consent prior to participation in the study (CU IRB# 2021-0284). This study evaluated 163 undergraduate students enrolled in an introductory animal and veterinary science laboratory (AVS 1510) in the fall 2020 semester. The majority of the students were in the Animal and Veterinary Science major with the remainder in Genetics, Agricultural Education, Agribusiness, and Biology. The 110-minute laboratory course met once per week throughout the semester; the first three weeks were dedicated to orientation and material acquisition, so no assessments were given during these laboratories. The students had the option to take this laboratory course along with the lecture course, which met 50 minutes per day, three times a week. However, the two courses could be taken in separate semesters. Course material focused on animal handling and husbandry skills using equine, swine, dairy cattle, beef cattle, sheep, goats, and poultry.

Due to the COVID-19 pandemic, the course was initiated online and was transitioned mid-semester to in-person instruction to abide by the Clemson University COVID-19 regulations. Due to these regulations, all instructors were required to make class materials available in an online format for any student who may have been exposed to the virus. Virtual laboratories were posted on the university learning platform, Canvas™ (Instructure, Salt Lake City, UT), for students to view at their convenience. The laboratories covered a different species each week (Figure 1). Species covered virtually included equine, dairy

Figure 1.

Class timeline of material presentation and associated assessments



Note. Class timeline for assessments. The species of interest is depicted above each respective week. Quizzes are represented by the black vertical arrows and exams are represented by the grey vertical arrows. The black horizontal arrow represents the semester progression.

cattle, swine, poultry, and goats. The videos included guest lectures from departmental faculty and farm staff associated with the species of interest for that laboratory. The in-person laboratories were held at a different farm each week where students had to travel to each farm. Species covered in-person included equine, dairy cattle, swine, sheep and beef cattle. Assessments included a weekly quiz on the species discussed that week in addition to a midterm and non-cumulative final exam. Due to semester time restrictions, the goat quiz was added to the midterm exam and students were given 75 minutes to complete the assessment. All assessments were given online using LockDown Browser© (Respondus, Redmond, WA). Students had 60 minutes to take exams and 15 minutes to take quizzes. During online exercises, students worked alone on their virtual course material, quizzes, and midterm exam. During in-person exercises, students were divided into groups of 4 to 5. In each group, where available, students with prior species experience were evenly dispersed throughout the groups. Where unavailable, a teaching assistant filled this role. This was an example of using socially shared metacognitive regulation in the groups (Iiskala et al., 2015; Wang and Wang, 2021). The goal was to include a student or teaching assistant in each group who had previous experience with that species and who could help the others understand the exercise for the day. Instructors encouraged students to take detailed notes during both the virtual and in-person versions of the laboratory to practice and reflect on metacognitive skills. Students took the quizzes and final exam individually.

Throughout the semester, students were asked to answer a series of voluntary questionnaires administered through Qualtrics™ (Qualtrics, Provo, UT). Student perceptions of the course and assessments were gathered using four questionnaires administered before and after the midterm and final exams (Figure 2). Pre-exam questionnaires were active for two weeks prior to the midterm or final exam. Post-exam questionnaires were active for two weeks after the midterm or final exam. The pre- and post-midterm questionnaires had 16 and 15 questions, respectively, whereas the pre- and post-final questionnaires had 20 questions each. Questions included a variety of multiple choice, Likert-scale and open-ended questions. Data were analyzed using JMP Pro 16 for all datasets (JMP Pro 16, JMP, Cary, NC). Questionnaire responses were recoded and analyzed using Chi square analysis to assess proportional differences in responses between modalities. Analysis of student performance was compared using t-tests. Statistical significance was set at $P < 0.05$.

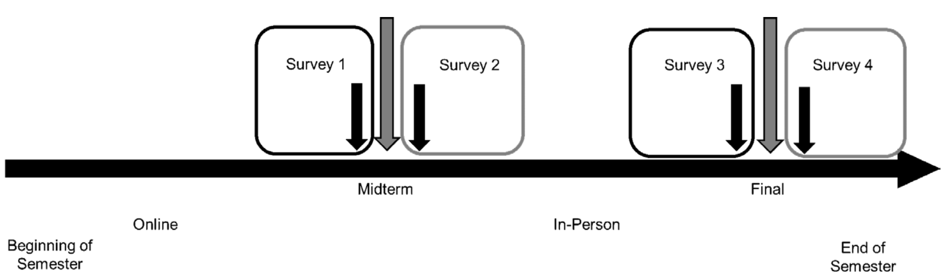
Results

Student Perception of Modality Pre-Assessment (Online vs. In-Person)

Student pre-exam perceptions across modality (online vs. in-person) are presented in Table 1. There were no differences across modality in student perception of pre-exam grade expectation ($P = 0.1318$), the amount of time students spent on this class ($P = 0.4758$), student

Figure 2.

Class timeline for student questionnaire release



Note. Class timeline for student questionnaire release. Each grey vertical arrow indicates an examination. Each black vertical arrow indicates where a survey was given. Each box indicates the timeframe in which the survey was active for students to take.

Table 1.

Student Perceptions of Online vs. In-Person Class Modality Pre-Exam

Question	Response	Online (Percent)	In-Person (Percent)	*p*-value
Grade Expectation	A	79.1	73.5	0.1318
	B	18.7	24.9	
	C	0.7	1.7	
	D or lower	1.4	0	
Time Spent on AVS	A lot	6.5	4.4	0.4758
	Moderate	43.2	49.2	
	A little	50.4	46.4	
Motivation for AVS	Yes	84.9	84.5	0.9960
	Maybe	8.6	8.8	
	No	6.5	6.6	
Motivation for Other Courses	Yes	67.6	58.9	0.2492
	Maybe	22.3	26.7	
	No	10.1	14.4	
Enjoyment AVS	Yes	92.8	93.9	0.4278
	Maybe	6.5	6.1	
	No	0.7	0	
Meeting Style Preference	Asynchronous	40.3	11.6	<0.0001
	Mix	39.6	63.5	
	Synchronous	20.1	24.9	
Virtual Preference	Online	12.2	6.1	0.1396
	Mix	36.7	42.0	
	In-Person	51.1	51.9	
Note Taking	Yes	78.4	36.5	<0.0001
	Maybe	10.8	41.4	
	No	10.8	22.1	
Quiz Question Fairness	Yes	73.4	82.3	0.0003
	Maybe	18.7	5.0	
	No	7.9	12.7	

motivation for this course (P = 0.9960), student motivation for other courses (P = 0.2492), student perception of class enjoyment (P = 0.4278), and student preference of virtual modality (P = 0.1396), such as online, mixed, or in-person instruction (Table 1).

Student perception of meeting style preference was significantly different across modality (P < 0.01). During the online portion of the course, students preferred asynchronous presentation (40.3%) and a mix between asynchronous and synchronous (39.6%) as compared to synchronous class meetings (20.1%) (Table 1). During the in-person portion of the class, however, students preferred a mixture of asynchronous and synchronous class meetings (63.5%) as opposed to only asynchronous (11.6%) or only synchronous class meetings (24.9%) (Table 1).

From the questionnaire, students reported their note taking behavior was significantly different across modality (P < 0.01). Students reported taking more notes (78.4%) during the online portion of the class than the in-person portion (36.5%) of the class (Table 1).

Perception of quiz question fairness was rated significantly different across modality (P = 0.0003). During the online portion of the class, most of the students reported that quiz questions were fair (73.4%) (Table 1). However, during the in-person portion of the class, only 36.5% of students reported that quiz questions were fair and 41.4% of students were unsure if quiz questions were fair (Table 1).

Student Perception of Modality Post-Assessment (Online vs. In-Person)

Student perceptions post-exam across modality are presented in Table 2. Students reported no significant difference in their understanding of class material (P = 0.5459), perception of exam difficulty (P = 0.2492) and whether they studied sufficiently for the exam (P = 0.6383) across modality (Table 2).

After taking each of the two exams, students reported performing significantly different than they had expected on the exam across modality (P = 0.0304). Students thought they performed better (36.3%) or the same as they expected (39.2%) during the online portion of the course (Table 2). During the in-person portion of the course, students reported they performed better than expected (30.3%) or the same as expected (31.6%). In comparing online vs. in-person exam expectations, there was a shift across modality from 24.6% to 38.2%, respectively, of students who believed they performed worse than expected (Table 2).

Student perception of exam question fairness was significantly different across modality (P = 0.0015). During the online portion of the class, students reported exam questions were fair (73.7%) (Table 2). Students (19.3%) were unsure if exam questions were fair or reported exam questions were unfair (7.0%) during the online portion of the class. During the in-person portion of the class, students reported exam questions were fair (57.9%), being unsure of exam question fairness (23.0%) or exam questions were unfair (19.1%) (Table 2).

The amount students planned to study for exams was significantly different across modalities (P < 0.001). Students reported having studied more (77.2%) for the exam in the online portion of the class versus the in-person portion of the class (Table 2). The students further reported they felt they should have studied more for the exam during the in-person portion of the class (59.2%) (Table 2). Among the student responses, only 22.8% indicated they studied enough during the online portion of the class and only 28.3% reported they studied enough during the in-person portion of the class (Table 2). No students reported wishing they had studied less for the exam during the online portion of the class, but 12.5% of students reported they had studied less for the exam during in-person portion of the class (Table 2).

Student perception of class difficulty was significantly different across modalities (P = 0.0002). During the online portion of the course, there was a fairly even spread across student perception of class difficulty (36.3% responded yes, 30.4% responded maybe, 33.3% responded no) (Table 2). During the in-person portion of the course, students thought the class difficulty decreased (17.1% responded yes, 32.9% responded maybe, 50.0% responded no) (Table 2).

When asked if the students felt overwhelmed with course material, there were significant differences across modalities (P = 0.0002). Students reported feeling overwhelmed (58.5%) during the online portion of the course (Table 2). During the in-person portion of the course, students reported a decrease in feeling overwhelmed (40.8%) (Table 2). Students who felt they could manage their coursework effectively during the online portion of the class (24.6%) increased during the in-person portion of the class (46.1%) (Table 2).

Student Performance

Student grades are reported in Table 3. For the dairy cattle quiz, average scores were greater in the online section compared with the in-person section, respectively (90.24 ± 0.81 vs. 78.36 ± 0.81). The horse quiz average scores were greater in the online compared with the in-person section, respectively (88.18 ± 1.41 vs. 79.16 ± 1.41). Quiz scores for the swine section were greater in the in-person portion of the course compared with the online portion, respectively (83.37 ± 1.07 vs. 79.60 ± 1.07).

Student exam averages were greater in the online portion of the course compared with the in-person portion, respectively (92.72 ± 0.65 vs. 87.73 ± 0.65). When analyzing student time spent on Canvas™, students spent a greater amount of time (minutes) on Canvas™ in the online portion of the class compared with the in-person portion, respectively (466.53 ± 27.13 vs. 367.00 ± 27.13; P = 0.0104). For the in-person portion of the class, students had access to video recordings of all laboratories. When analyzing the impact Canvas™ time had during the online modality, on each of the three quizzes (horse, dairy, and swine) and the midterm exam, there were no significant differences (P = 0.4140, P = 0.5277, P = 0.4027, P = 0.2931, respectively). When analyzing the impact Canvas™ time had during the in-person modality, on each of the three quizzes (horse, dairy, and swine) and the final exam, there were no significant differences (P = 0.6847, P = 0.5277, P = 0.2998, P = 0.1556, respectively).

Table 2.

Student Perception of Online vs. In-Person Class Modality Post-Exam

Question	Response	Online (Percent)	In-Person (Percent)	*p*-value
	Better	36.3	30.3	0.0304
Exam Performance	Same	39.2	31.6	
	Worse	24.6	38.2	
	Yes	73.7	57.9	0.0015
Exam Question Fairness	Maybe	19.3	23.0	
	No	7.0	19.1	
	More	77.2	59.2	<0.0001
Study Amount Compared with Midterm	Same	22.8	28.3	
	Less	0	12.5	
	Yes	36.3	17.1	0.0002
Class Difficulty	Maybe	30.4	32.9	
	No	33.3	50.0	
	Good	81.3	84.2	0.5459
Understanding Level	Average	18.1	14.5	
	Poor	0.6	1.3	
	Easy	39.8	30.9	0.2492
Exam Difficulty	Neither	28.1	32.9	
	Difficult	32.2	36.2	
	Yes	58.5	40.8	0.0002
Overwhelmed	Maybe	17.0	13.2	
	No	24.6	46.1	
	Yes	71.9	75.0	0.6383
Spent Enough Time Studying	Maybe	20.5	16.4	
	No	7.6	8.6	

Discussion

The differences between online and in-person instruction were evaluated for an introductory animal and veterinary sciences laboratory-based course. Student perceptions of the course and of their personal standing in the course were assessed prior to and after each examination. Throughout the semester, student motivation for the course remained high as did enjoyment for the course material (Table 1). Student motivation is directly linked to the degree of student success in a course (Pellas and Kazanidis, 2015). Specifically in a blended course, student motivation impacts the connections between students and their peers, as well as interactions with the class material (Pellas and Kazanidis, 2015). When motivation is high, interactions are also high, indicating students are engaging in the course and the provided material is suitable for the effective instruction of the course (Pellas and Kazanidis, 2015).

As a one credit course, in this study it was expected students would report spending a little (0 to 4 hours) to a moderate (4 to 8 hours) amount of time on this course (Table 1). Anything beyond studying 8 hours per week for

Table 3.

Student Performance in Online vs. In-Person Class Modality

Assessment	Online Mean	In-Person Mean	Standard Error	Mean Difference	p-value
Dairy Quiz (%)	90.25*	78.36	0.81	11.88	<0.0001
Horse Quiz (%)	88.18*	79.16	1.41	9.02	<0.0001
Swine Quiz (%)	79.60*	83.37	1.08	3.77	0.0145
Exams (%)	92.72*	87.73	0.66	4.99	<0.0001
Canvas™ Time (mins)	466.53*	367.00	27.14	99.53	0.0104

Note. *Data not shown; no significant differences were noted (P > 0.05) between Canvas™ Time (mins) and student assessment scores.

this laboratory (outside of the class period) would possibly indicate that student understanding of the material and student metacognitive regulation skills were poor (Carr, 2010; Stanton et al., 2015; Stephanou and Mpiontini, 2017). Student self-assessment of their understanding of the material was positive throughout the semester. Other studies have indicated when students report positively on their self-evaluation, there is an improvement in self-regulation of learning (Ackerman and Goldsmith, 2011; Avargil et al., 2018). In the present study, this positive response of capability from the students indicated a majority of the students were able to effectively use their metacognitive regulation skills when approaching the material and, as a result, this may have influenced their overall class performance (Ackerman and Goldsmith, 2011; Stanton et al., 2015; Avargil et al., 2017). Perception of individual performance has a direct impact on student confidence, comprehension, and metacognitive regulation in science learning (Carr, 2010; Ackerman and Goldsmith, 2011; Avargil et al., 2018).

The amount of time students spent on this course and their self-reported understanding of the material are consistent (Table 1 and Table 2). This relationship is also consistent with student grade expectation where students believed they would earn an A grade in this course, prior to taking their examinations (Table 1). As per self-reported attributes including personal study habits, comfort with the subject material, feeling motivated for this course, spending an adequate amount of time on the material, enjoying the class subject, and understanding the material, all provide insight that students felt confident in this class and expected to receive an A grade in the course (Ackerman and Goldsmith, 2011; Pellas and Kazinidis, 2015).

When asked about exam difficulty after taking the exam, there was a fairly even distribution of responses across yes/maybe/no for both instructional modalities. Results indicated some students may be less developed in their metacognitive skills than others (Carr, 2010; Stanton et al., 2015). Students were asked after taking the exam if they thought they had spent enough time studying, to which a majority of the students replied “yes” (Table 2). From this response, it is clear students were able to employ their metacognitive skills (Stanton et al., 2015). A student’s metacognitive knowledge indicates they can differentiate between what they know and what they need to study (Carr, 2010; Stanton et al., 2015). Metacognitive regulation involves a student’s ability to understand and control their thinking in a way that they can understand the task at hand, identify their personal strengths and weaknesses regarding that task, create a plan to achieve the task, monitor the plan for success and adjust the plan, as necessary (Carr, 2010; Stanton et al., 2015). After taking the exam, a disconnect between the student’s metacognitive knowledge and metacognitive regulation was noted. Results of the study indicated the amount of time students spent studying in relation to the material studied influenced class performance (Carr, 2010; Stanton et al., 2015). Most of the students were first-year (freshman) students who may or may not have developed metacognitive abilities (Carr, 2010; Stanton et al., 2015; Avargil et al., 2018). Metacognition is a skill that can be developed in science education over time; it is imperfect and age-dependent (Brown, 1978; Avargil et al., 2015; Stephanou and Mpiontini, 2017). From the responses on questionnaires and student performance on the exams (Table 3), students were aware of what they needed to study and the majority of the class acted on those needs (Stanton et al., 2015; Avargil et al., 2018). There were 7 out of 163 students who earned a D or F grade in the class. In this case, it would appear there was a disconnect in metacognitive regulation, which is commonly witnessed in students who do not change their actions after receiving a poor grade (Jacobs and Paris, 1987; Carr, 2010; Stanton et al., 2015; Stephanou and Mpiontini, 2017). The high percentage of A and B grades (67.48% and 25.15%, respectively) is contradictory to the responses students provided when asked if they thought exams were difficult (Table 2). For this question, students responded fairly equally across yes/maybe/no regarding test difficulty, which indicates student reporting of exam difficulty was inaccurate (Table 2). Students reported on questionnaire 2 that they planned to study less for the final than for the midterm. Later responses on questionnaire 4 indicated students did indeed study less for the final than the midterm. Grades on the final reflected this. Therefore, it is assumed that the student reports of exam difficulty were emotional responses and a result of poor metacognitive regulation (Stanton et al., 2015).

When comparing student performance on exams, there was a shift across modality where students performed better during the online portion of the course compared with the in-person portion of the course (Table 3). Student interactions during the in-person portion of the class should have increased student engagement due to peer interactions and collaborative learning (Pellas and Kazinidis, 2015). However, Pellas and Kazinidis (2015) reported similar results to the present study. Students in a blended learning course were compared to a completely online course format by Pellas and Kazinidis (2015) and their results indicated students in the online section had greater engagement with the material and performed better in the course. In the present study, after taking the final exam, students reported they had spent enough time studying and they understood the material, so it would be expected that students would report the exam as easy to moderate in difficulty. It is possible the metacognitive skills of students were lower during the in-person portion of the class because there were more stressors involved such as transportation to the laboratory, handling of live animals, and interacting with classmates (Iiskala et al., 2015; Stanton et al., 2015). Many students were not engaged with the instructor due to their distraction with handling the animals (Pellas and Kazinidis, 2015; Wang and Wang, 2021). Engagement with the instructor, peers, and material are all necessary for student success in a course, especially with a blended format (Pellas and Kazanidis, 2015; Wang and Wang, 2021). However, because the modality of the laboratory course in the present study changed mid-semester due to the pandemic, we expected an increase in socially shared metacognitive regulation and, thus, an increase in student performance (Iiskala et al., 2015).

There was a clear decrease in Canvas™ usage during the in-person portion of the class (Table 3). However, analysis of data indicated there was no significant difference in time spent on Canvas™ in relation to quiz or exam scores (Table 3). If students felt they had studied sufficiently during both modalities, this perception should be reflected in performance on assessments. The decrease in Canvas™ usage may be a function of students reporting they took fewer notes during the in-person portion of the class, despite being encouraged each week to take detailed notes on class material, which is another indicator that metacognitive skills in this group of students may have been underdeveloped (Stanton et al., 2015; Avargil et al., 2018).

Students reported a shift in assessment fairness. During the online portion of the class, both quizzes and exams were thought to be fair. During the in-person portion of the class, half of the students had changed their opinion and expressed the quizzes were unfair. Similarly, students also thought exam questions during the in-person portion of the class were either unfair or less fair than the online portion of the class (Table 1 and 2). This perception could be a function of students taking fewer notes in addition to reporting they had planned to study less for the in-person final exam compared with the online midterm exam. Planning to study less for a future exam indicates students were aware of their knowledge base and study needs, but when comparing student perceptions to the class performance on exams, a lack of adequate metacognitive abilities in this group of students was observed (Stanton et al., 2015; Stephanou and Mpiontini, 2017).

Students reported an overall decrease in feeling overwhelmed from the online to the in-person portion of the course (Table 2). Students reported thinking the difficulty of the course decreased in-person, so it is unclear why student performance decreased in the in-person portion of the course (Table 3). Overall, it appears that student performance decreased due to a reduction in note taking, an intentional decrease in time spent studying, and students becoming too comfortable with the course when it transitioned to the in-person modality. This concept is demonstrated when comparing student perceptions of expected grade prior to taking the exam and reflective exam performance post-exam (Stanton et al., 2015). In surveys 1 and 3 conducted prior to each exam, most students reported across both modalities that they expected to receive an A grade for the course (Table 1). In survey 2, conducted after the midterm exam but prior to grades being returned, students reported having performed better than expected on the midterm (Table 2). In survey 4, students reported performing the same or worse than they expected on the final (Table 2). After completion of the exams, actual student performance was better during the online (midterm exam) than the in-person (final exam) portion of the course (Table 3). Having performed the same or better than expected during the first half of the semester (online) likely led to a decrease in study habits and note taking behavior and an increase in student confidence regarding their assessments. It is speculated this led to the decrease in assessment scores during the second half of the semester (in-person). The responses indicate that students were stressed prior to taking their examinations. The students were reflective of their class standing after the assessment and after having made the choice to decrease studying and note taking. Students perceived that the difficulty of the class decreased as well. The shift in modality could also have impacted student behaviors, perceptions, and metacognitive regulation (Stanton et al., 2015; Stephanou and Mpiontini, 2017). When taking an online course, mental stimulation is different compared with an in-person course or with blended learning (Pellas and Kazanidis, 2015; Wang and Wang, 2021).

There was a clear shift across modality for preference of meeting style (Table1). Students preferred to meet asynchronously for online instruction. Students preferred a mixture of asynchronous and synchronous meeting styles during in-person instruction. Across both modalities, students had a strong preference for in-person meeting style (Table 1). This preference shift is likely due to the nature of online courses where students tend to perform individually compared with a more collaborative learning style when instructed in-person (Iiskala et al., 2015; Pellas and Kazinidis, 2015; Wang and Wang, 2021). Additionally, the desire of the students to interact with the animals likely strongly influenced the preference for in-person meeting style. In collaborative settings, the quality of learning improves as a result of improved student engagement and stimulation of individual cognition (Iiskala et al., 2015; Pellas and Kazinidis, 2015). Asynchronous learning can prove beneficial in discussion-based courses as it provides a greater amount of time for thought and reflection on subject material (Wang and Wang, 2021).

Asynchronous learning can be detrimental as student engagement and interaction are less compared with synchronous learning styles (Wang and Wang, 2021). As was recorded in student performance in the present study, there was a difference in quiz performance for all species (Table 3). Additionally, exam performance between the two modalities were significant (Table 3). As a general trend, students performed better during the online portion of the course compared with the in-person portion of the course, which is in direct contradiction with the concept that students perform better when instructed in-person (Iiskala et al., 2015; Pellas and Kazinidis, 2015).

Summary

When evaluating student motivation, there were no differences across modalities of instruction for in-person versus online. Motivation is directly linked to self-regulated learning, which did not change during the semester (Pellas and Kazinidis, 2015). This is in contradiction with the student performance on quizzes and exams as students performed better during the online portion of the course (Iiskala et al., 2015; Pellas and Kazinidis, 2015). Despite having spent more time on Canvas™ during the online portion of the class, there was no impact of time spent on Canvas™ compared with any assessment. Therefore, the amount of time spent online was not a factor in student performance in this class across modality (Iiskala et al., 2015; Pellas and Kazinidis, 2015). Interaction time with the virtual platform should have been an indicator for class performance as an example of student management of the material and subsequent performance on assessments (Pellas and Kazinidis, 2015). If the class scenario were reversed, and students had started the course in-person and completed the semester online, there is a question if changes in socially shared metacognitive regulation and metacognition would have occurred. Other factors not considered in this study, which could have influenced results, include actual differences in difficulty of quizzes and exams, external factors, etc. Future studies should be designed to evaluate additional factors which may influence student responses. However, in conclusion, this study supports online educational modalities as an effective method for teaching an introductory animal and veterinary science laboratory-based course.

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