Impacts of the COVID-19 Pandemic on Student Performance and Perceptions of Learning

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Abstract

The COVID-19 pandemic has greatly affected higher education, but when learning shifted to an online environment it provided an opportunity to gain insight into how classroom format influences student performance and preferences. Thus, our objective was to assess student performance across classroom types, along with student perceptions of learning, to better understand the learning environment at the height of COVID-19. We evaluated student performance by final grade in undergraduate animal genetics (ANEQ 328) and large animal physiology (ANEQ 305) courses across four semesters, from before the pandemic through the return to in-person learning. In addition, students received surveys with questions regarding their learning experience. Survey analysis showed a consistent influence of COVID-19 within the classroom, mostly due to secondary effects. Student performance increased ($P < 0.05$) or was maintained in the pandemic centered semesters compared to pre-pandemic scores. When in-person learning resumed, scores in the ANEQ 305 course were worse ($P < 0.05$) than any previous semester but scores in the ANEQ 328 course returned to pre-pandemic levels. Overall, this study indicated that student performance was not negatively affected by the online transition during COVID-19 in these two courses, but it did decrease student satisfaction with their learning.

Keywords: animal science, COVID-19, performance, perceptions, undergraduate

March of 2020 brought about many unprecedented challenges to the world of academia as a result of the COVID-19 pandemic. March 15th, 2020 marked the beginning of national lockdowns within the United States and universities followed shortly after. Multiple universities moved all courses online awaiting further information from state officials. This caused a sudden adjustment of all courses to online formats upon return from spring break. Subsequently, in-person campuses were closed for the remainder of the semester, keeping all classes and services in a virtual format. As many universities have transitioned back to in-person courses, there is a great opportunity to evaluate the impacts of the COVID-19 pandemic on university students in order to inform instructional practices

moving forward.

Over the past decade, the utilization of online post-secondary courses has progressively increased, along with empirical research regarding efficacy of online instruction (Palvia et al., 2018; Parker et al., 2011), and this has substantially increased even more so since the onset of the COVID-19 pandemic (Masalimova et al., 2022). Previous research of virtual versus face-to-face learning has generated results in favor of virtual and flipped classrooms, however, the sudden nature of this transition elicited additional barriers to virtual learning. Various studies occurring prior to the COVID-19 pandemic indicated either increased (Connolly et al., 2005; Vaccani et al., 2016) or maintained (Moridani, 2007; Soffer and Nachmias, 2018; Solomon et al., 2004) student performance within virtual undergraduate courses suggesting that online learning throughout disciplines can be as effective as the in-person alternative (Soffer and Nachmias, 2018; Swan, 2001). However, it is important to note that performance is not always indicative of learning, and success relies on mediating barriers that are innate to the online environment and those that are student specific. Previous studies have found that student-to-student and instructor-to student interactions, sense of community (Picciano, 2002), understanding of online pedagogy, qualified faculty (Kentor, 2015), and consistency in quality of teaching between in-person and online courses can be major hinderances to successful online learning and student experience. Studies particularly focused in physiology-based courses demonstrated similar student performance despite format, but a greater student preference for in-person course facilitation, specifically in-person lectures (Cardall et al., 2008; Moridani, 2007). Since many changes to student performance and perception are known to be attributed to teaching styles and assessment strategies (Marden et al., 2013; Roby et al., 2013; Swan, 2001), the sudden and extreme changes to undergraduate courses brought about by the pandemic would reasonably be expected to influence student performance.

Technological capability (Sahu, 2020) provided greater barriers to student learning than years prior to the pandemic. Adaptations of course materials and assessment formats relied wholly on technological capabilities of universities and faculty (Kearns, 2012). Accessibility of technology to faculty and students also influenced the presentation and receptibility of course content. This technological barrier along with added stress of the pandemic itself increased mental health strain for both students and instructors (Al-Rabiaah et al., 2020). Students and professors alike mentioned increased stress due to altered schedules, workloads, and apprehension of the virus. The added stressors of the COVID-19 pandemic presented an altered environment for virtual learning, warranting the need for further investigation of pedagogical practices. Thus, the objective of this study was to assess student performance across four classroom types, along with student perceptions of learning, to better understand the impact of instructional practices and barriers to learning brought on by COVID-19. Based on previous research in online courses, along with the known challenges of the COVID-19 pandemic experienced by instructors and students, we hypothesized a hindrance in student performance along with negative perceptions of learning by undergraduates throughout online semesters, due to the abrupt shift to online learning, with improved performances and perceptions as courses returned to an in-person setting.

Methods

Informed Consent of Participants

All procedures for data collection were reviewed and approved by the Human Subjects Institutional Review Board (IRB) at Colorado State University. Prior to conducting the study, students were informed of the option to participate and share performance and survey data contributing to this project. Students were compensated for their participation with a 2% increase in their final grade, with nonparticipating students receiving the same bonus for an equal alternative effort. Survey submissions were anonymous and student grades were deidentified by an outside party before beginning analysis.

Classroom Setup

Student performance data was collected in two undergraduate animal science courses, Functional Large Animal Physiology (ANEQ 305) and Foundations in Animal Genetics (ANEQ 328), over four semesters. Semester 1 took place prior to the pandemic. Both ANEQ 305 and ANEQ 328 courses (n = 97 and n = 137, respectively) during this semester were taught in-person utilizing a traditional didactic format consisting of professor-led lectures two to three times weekly, with four exams given throughout the semester. Semester 2 (ANEQ 305 n = 81, ANEQ 328 n = 138), marked the beginning of the COVID-19 pandemic. Prior to university shutdown, courses were conducted in a fully in-person setting. During this time, both courses were taught similarly to the previous semester, comprised of the traditional lecture and exam format. The increasing presence of COVID-19 within the United States warranted a sudden mid-semester transition of courses to a fully online setting, to avoid spread of the virus within university settings. For the remainder of Semester 2, courses followed an asynchronous virtual format. Lectures were recorded and uploaded to the online learning management system Canvas (Salt Lake City, UT), allowing students to participate at their own convenience. Student assessments of knowledge were administered as asynchronous online exams and quizzes. Students were not permitted to use course notes or outside sources during assessments but were not monitored throughout the duration of assessment. Semester 3 (ANEQ 305 n = 126, ANEQ 328 n = 97), occurred during the height of the pandemic prompting both courses to follow a hybrid classroom model. Asynchronous lectures were recorded and provided on the Canvas platform throughout the semester allowing students to watch at their own leisure. The same questions from the exams given as assessments in semester 1 were broken down into 13, 10 question quizzes aligning with lecture objectives and administered weekly via Canvas for both courses. Utilizing the same

questions allowed for a clearer understanding of the impact of assessment strategy without increased variability due to question format. Students were allotted 15 minutes to complete the quiz, were not permitted to utilize outside sources or course notes, but were not monitored. In addition to the online setting, students in each course were offered an optional in-person recitation once weekly, allowing for in-person interaction with both the professor and teaching assistants. The online classroom settings utilized identical course objectives and subject matter as courses previously taught in person. The final semester, Semester 4 (ANEQ 305 n =47, ANEQ 328 n = 91), represented a fully in-person post-pandemic restrictions course. Both courses followed a similar format to that of semester 3 consisting of weekly quizzes as the predominant assessment strategy. However, quizzes and lectures were conducted synchronously and in-person, removing the need for recitation. Students once again were allotted a 15-minute time-period to take quizzes once a week and were not permitted to use outside materials or notes. Recordings of in-person lectures were provided to students, allowing students to access lectures at their convenience.

Student Surveys

Surveys were administered anonymously through Canvas in semesters 3 and 4. The survey was provided at the end of the semester allowing for evaluation of changes in student perceptions throughout the duration of the course. Each survey consisted of eight Likert scale, one select all that apply, and two free response questions aimed at understanding student perceptions of learning and course design in two vastly different settings. However, for this study only five Likert scale, one free-response, and the select all that apply question were evaluated. Likert scale questions utilized a ranking of 1 to 5 with response options of Completely Disagree (1), Somewhat Disagree (2), Undecided (3), Somewhat Agree (4) and Completely Agree (5), unless otherwise noted. The free response question was aimed at understanding factors that affected student learning as well as those that contributed to success.

Statistical Analysis

Student Performance

Student data of non-consenting individuals was not included in this study. Data was deidentified and cleaned to remove students that did not pass the course with a D or better. Performance was determined based on the culmination of scores on assessments (exam or quiz) and homework assignments with all other point opportunities excluded from final grade calculations. Student final grades were analyzed by ANOVA and pairwise comparison using a simple linear regression in R software version 4.0.3 (R Core Team, 2020) to evaluate student performance across semesters. Means were considered different at $P < 0.05$. All data are presented as mean ± standard error.

Student Perceptions

End-of-semester surveys were combined across semesters in both ANEQ 305 and ANEQ 328 to form pandemic centered and post-pandemic survey results. A thematic analysis of free response questions was completed to determine primary and secondary influences of the pandemic that may alter overall student performance or perceptions. Likert scale questions in the final survey were combined by semester to determine the proportion of students affected by primary or secondary influences of the pandemic as well as perceptions of personal performance in an online versus in-person course setting.

Results

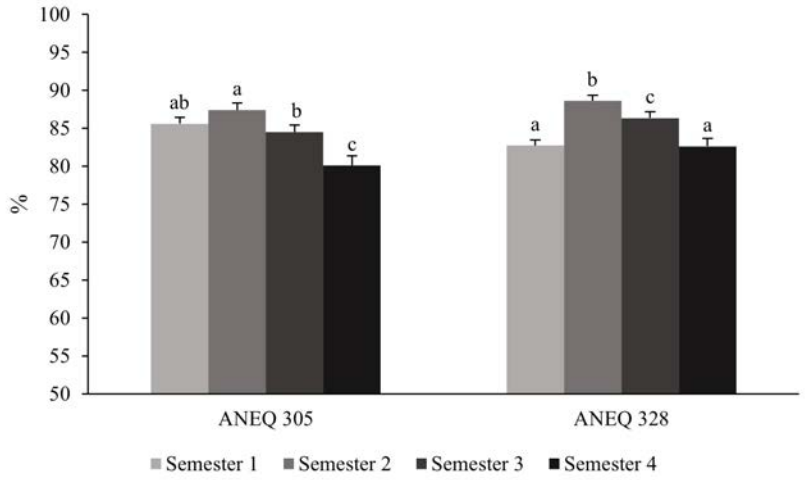
Quantitative analysis of student final grades determined substantial differences in both courses (Figure 1). Student performance in the online classroom (semesters 2 and 3) of ANEQ 305 did not differ from the pre-COVID-19 classroom, but student performance decreased ($P < 0.05$) between the transitionary and fully online classes. Additionally, student final grades were lower ($P < 0.05$) than any previous semester upon return to in-person learning in semester 4. In ANEQ 328 students performed better ($P < 0.05$) within the pandemic-based semesters compared to semester 1 or 4, which did not differ. ANEQ 328 student final grades decreased ($P < 0.05$) from semester 2 to 3 and returned to pre-pandemic levels in semester 4.

Despite no change or improved student performance in semesters 2 and 3, student surveys indicated frequent educational disruptions due to secondary impacts of the pandemic rather than COVID-19 itself. Indeed, self-reports of contracting COVID-19 or caring for someone with COVID-19 seemed to affect the smallest percentage of students between semesters with approximately 32% and 18% of students in semesters 3 and 4, respectively, indicating either of these as a barrier to learning (Figure 2). Conversely, the majority of students reported mental health, time management, course load, and working more as the greatest factors affecting their ability to learn through the duration of the 3rd semester. Mental health burdens stayed consistent through the results of the post-pandemic semester survey; however, it did show an approximately 9% decrease in reported course load barriers and 15% decrease in reported time management barriers.

Likert scale responses showed similar perceptions of course difficulty between semesters, as on a scale from too difficult to too easy, the majority of students reported course difficulty was either just right or somewhat difficult in semesters 3 and 4 (92.6% and 90.4%, respectively). Additionally, the majority of students in both semesters felt they were able to keep up with course material and felt prepared for the subsequent courses (Figure 3). Major differences in survey results occurred when asking about preferences of synchronous or asynchronous learning. Just over half of students in semester 3 reported that they completely or somewhat agree with a preference for asynchronous over synchronous learning. Conversely, approximately a third of the students in semester 4 completely or somewhat agree

Figure 1.

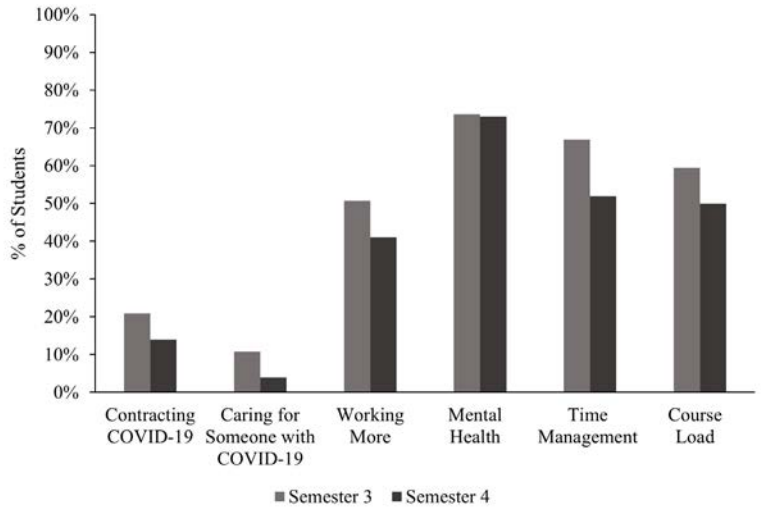
Student Performance by Average Final Grade



Note. ANEQ 305= Functional Large Animal Physiology and ANEQ 328= Foundations in Animal Genetics. Average final grades were assessed in each course from four course types, semester 1 = pre-pandemic fully in-person; semester 2 = mid-semester transition; semester 3 = fully online; semester 4 = return to in-person. [a,b,c] Means with different superscripts differ between semesters ($P < 0.05$).

Figure 2.

Self-Reported Factors Affecting Student Learning



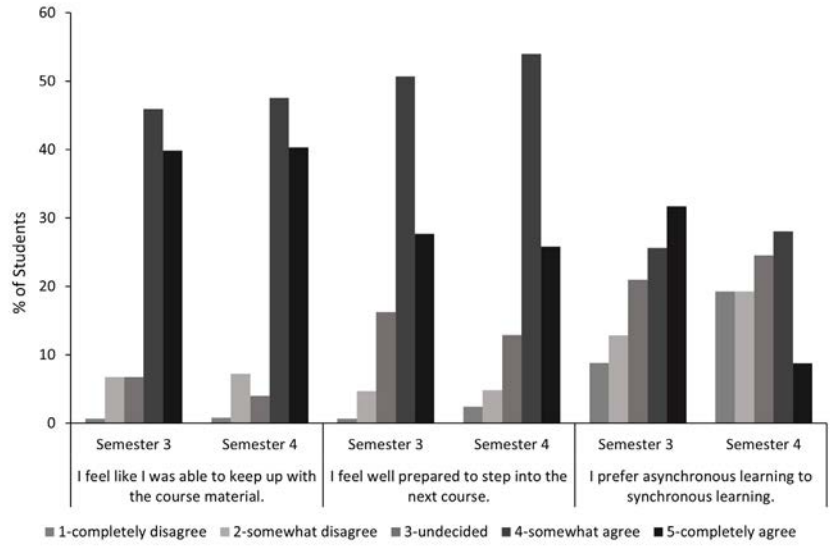
Note. Students were instructed to select all that apply. Semester 3 = fully online, Semester 4 = return to in-person learning.

that they prefer asynchronous versus synchronous learning. Finally, while only available in semester 4, the majority of students (65%) reported that they completely or somewhat disagree that livestream or recorded lectures from the in-person class deter them from attending.

Thematic analysis of the free response survey question "What impacted your success in this course?" indicated recurring themes relating to pandemic influence through semester 3. First, a large proportion of students self-reported fear of catching COVID-19 or increased workloads as major barriers to attending optional in-person recitations during semester 3 (Table 1). Students within this semester also reported a dislike for online learning and eluded towards expected improved performance in an in-person setting. Semester 4 free response questions did not reference disturbances due to COVID-19, but rather due to an increased workload from the course or other responsibilities. However, students within both semesters expressed gratitude towards the formative assessment types, stating an ease of mental health.

Figure 3.

Perceptions of Learning Across the COVID-19 Pandemic



Note. Students were instructed to rate their agreeance with a given statement on a Likert-scale from 1-5. Semester 3 = fully online, Semester 4 = return to in-person learning.

Table 1.

Overarching Themes of Self-Reported Factors that Affected Student Success

Fear of Contracting COVID-19
•"I have not attended because I'm scared about COVID, I would love to attend but I live with my mother and I don't want to put her at risk."
•"I am nervous about getting the virus, because I cannot afford to miss work. "
Expectation of Learning Better in Person
•"This course is challenging, and I think online learning makes it harder to understand the content for me especially when there isn't a lot of contact and connection with my professor, the TA's and other classmates."
•"I think this course is great! I wish I could be taking it in person because I learn better and am able to retain the information much better!"
Formative Assessment Eases the Mental Burden
•"I have really liked the smaller quizzes because I feel it makes the information given a lot easier to understand and it makes it feel much more manageable than having these large scale exams that make the information become much more overwhelming."
• "I personally find that exams add stress and hurt my grade/learning more than it helps. The weekly quizzes and assignments have really helped me understand each topic and figure out where I need to review or practice more. "

Discussion

The COVID-19 pandemic provided the unique opportunity to assess student performance across various virtual and in-person formats with increased barriers to student learning. Previous literature suggests that online learning can be effective, as students tend to perform just as well as in-person equivalents when online course management is strategic and effective (Connolly et al., 2005; Soffer and Nachmias, 2018; Solomon et al., 2004). However, the students typically enrolled in online courses prior to the coronavirus pandemic tend to be non-traditional and enroll in these virtual courses voluntarily (Eaton, 2020), which does not necessarily translate to extemporaneous remote learning in an average student population. Student final grade data in this study showed that there was not a negative influence of the pandemic on overall performance within both undergraduate courses when evaluated by final grade. This is synonymous to other studies conducted at the time of the COVID-19 pandemic which determined an overall effectiveness of teaching within times of unexpected remote learning (Beason-Abmayr et al., 2021; Gopalan et al., 2021; Vollbrecht et al., 2020). Improvements in student performance in ANEQ 328 during pandemic-centered semesters (2 and 3) may be attributed to sudden changes in course format and assessment strategies, leniency of grading, or increased incidence of academic misconduct (Eaton, 2020; Reid, 2021).

The sudden transition to remote learning proved to be difficult on both instructors and students. This could be attached to a breadth of faculty without online instruction experience that found the transition to be very difficult (Roy and Covelli, 2021). Instructors were forced to adapt courses to fit the virtual format in very limited time resulting in removal or change to some course materials and altering lecture delivery methods (Volbrecht et al., 2020). Often, this included changes to assessment strategies, which decreased rigor by allowing use of course materials and notes or limiting the use of assessment proctoring. Conversations with professors and teaching assistants across departments also determined an apparent leniency in grading through COVID-19-based semesters to compensate for the added stress of virtual learning. Additionally, many universities and students themselves reported a greater incidence of academic misconduct throughout the pandemic (Reid, 2021), oftentimes justified as a result of added stress and uncertainty (Eaton and Turner, 2020). Although timed assessments utilized in this virtual format may have limited use of outside sources, it does not completely eliminate the opportunity for academic misconduct (Eaton, 2020). Indeed if cheating played a large role in increased performance, we suspect this will become apparent when cohorts of students are followed into subsequent courses and find increased challenge due to a lack of attaining prerequisite knowledge. In settings such as semester 3, where there was a planned online semester, student performance decreased from the transitionary semester. Having the experience of the previous semester and the opportunity to prepare courses, instructors found the online environment more comfortable (Roy and Covelli, 2021) which may have contributed to higher expectations and less leniency in courses. However, this decrease in performance was still higher or no different than pre-pandemic scores.

Although student performance was not substantially impacted throughout virtual semesters, reports of a dislike for online learning correlates with studies conducted on both undergraduate and postgraduate students. Chandran et. al., (2021) reported that although postgraduate students find an ease of access to information with asynchronous virtual courses, face-to-face learning is preferred for student-centered learning. Student dislike for virtual courses stated throughout semester 3 surveys is likely due to the nature of virtual learning during the pandemic, forcing students to take virtual courses that they typically would not register for and leaving students unprepared for virtual learning (Abassi et al., 2020, Kaur et al., 2020, Gopalan, 2021). Formative assessment and hybrid learning, as utilized in semester 3, has been shown to alleviate some mental strain in the typical online classroom (Gopalan et al., 2021) and was supported by student free-responses to survey questions in this study for both the in-person and virtual semesters. Student reports in free response questions consistently praised low stake assessment in the online and in-person class format, stating that they act as motivation to learn content weekly and ease some mental burdens typically placed on them by high pressure exams. Additionally, students in semester 3 courses stated formative assessment as an ease of stress during the uncertainty of the COVID-19 pandemic. The incidence of increased mental strain to students and instructors alike has been quite common throughout studies focused on pandemic-based education. Eaton and Turner (2020), Hussein et. al. (2020), Maqableh and Alia (2021), and Sahu (2020) all reported similar results of student perceptions, indicating an increased workload and mental strain among other non-COVID-19 related factors as the greatest barriers to online learning. Semester 4 perceptions are similar, indicating non-COVID-19 related factors as the greatest barrier to face-to-face learning. Workloads, course loads, and the need for better time management were likely directly altered by the pandemic, and while somewhat improved with the return to in-person learning, continue to persist as barriers to learning through semesters not concurrent with the COVID-19 pandemic. Indeed, though not demonstrated in our study, Clary et al. (2022), found that personal and environmental factors have actually given some college students the desire to continue with online learning, even with in-person options. Although many of these factors may be secondary to effects of the pandemic, it further demonstrates the need for consideration of outside influences when conducting online courses outside of the pandemic, as many students who willingly enroll in online education are facing outside barriers.

Semester 4, occurring after returning to the in-person classroom, removed the major barrier of forced online learning and improved the perceptions of many students, but did not improve performance and surprisingly, in ANEQ 305 student performance was the worst out of all evaluated semesters. While studies evaluating student performance after returning to the classroom are still being completed, we speculate that the removal of those aspects that allowed students to perform better in the transitionary classroom contribute to decreased final grade. For example, rather than self-paced learning students must return to instructor led learning, there is more strict proctoring of assignments and assessments, and a return to large summative assessments. These are compounded by a decrease in student attendance when returning to the in-person classroom, which has been shown to be a key indicator of success (Crede et al., 2010). This could also be attributed to remediation of self-regulated learning skills, inquiry skills, and social reengagement (Schaefer, 2022). This period of reengagement and decreased productivity termed the "COVID hangover" (Schaefer, 2022), can continually impact student performance as burnout through remediation increases. As instructors attempt to manage this "hangover" there is a need for continued research and understanding across larger time spans and variations in course format and assessments.

Summary

The COVID-19 pandemic caused many changes including a sudden transition to online learning, which neither student nor faculty were comfortable with. Anticipation regarding unforeseen consequences of emergency virtual learning in post-secondary education, prompted greater acknowledgement of student performance and perceptions. Despite hypotheses that performance would decrease

due to influences of the pandemic and online courses, student final grades were higher in semesters 2 and 3 during the pandemic as compared to the pre- and post-pandemic semesters. However, we cannot neglect the fact that performance is not always an indicator of learning or retention of knowledge, especially in an online non-proctored environment, and further studies are needed to investigate these outcomes after returning to the classroom. Despite stable or improved performance, student perceptions wavered. The online format was not ideal, but praises of course format and small-stake assignments improved outlook and possibly contributed to greater performance. Questions of academic misconduct in online settings and variation in stringency of grading is not to be discounted and could have greatly contributed to overall performance of online semesters. From this study, we can conclude that online education during the pandemic did not harm undergraduate student performance within these two animal sciences courses. However, continued investigation in this area will be important to help elucidate the lasting impacts of the COVID-19 pandemic on this cohort of students and instructional strategies implemented during this time.

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