EFFECT OF ANIMAL SCIENCE LECTURE MODALITY ON COURSE CONTENT MASTERY

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No conflicts of interest are present.

Abstract

Many education disciplines have indicated that academic performance of student-centered online learning can be just as effective as face-to-face (**F2F**) learning. We hypothesized that some animal science (**ANSC**) courses could increase their enrollment by offering online lecture sections. However, the equitability of student outcomes between modalities and majors was questioned. Therefore, the objective was to evaluate the student academic performance of a core ANSC course offered both online and F2F across several terms. The *Principles of Nutrition* course in the Animal and Food Sciences Department was selected for analysis. Course content, exams, and instructor were not changed for 9 semesters. Academic performance was measured as the mean percentage of four formal exams for each term, with 609 data points across 5 online sections (n = 207) and 5 F2F sections (n = 402). Academic performance was analyzed using nonparametric evaluation of means through Kruskal-Wallis test for the effect of modality (F2F or online) and major (ANSC or non-ANSC). Online students had greater academic performance than F2F students (P = 0.025). Major did not affect academic performance in this course (P = 0.205). In conclusion, there may be some flexibility in the modality of animal science course offerings.

Keywords: Online, face-to-face, modality, Animal Science

Growth in student enrollment is a positive metric that may indicate opportunities for students within a college or department. However, when holding capacity lags behind increased enrollment, this causes challenges in course scheduling and delayed course enrollment by students, ultimately hindering timely degree earning. We theorized that perhaps online section offerings for core animal science courses could help meet capacity needs after significant (27.2%) enrollment growth in the Texas Tech University Animal and Food Sciences department in 2019. In other fields of study, online learning has increased, and some colleges offer fully online degrees. In an increasingly technological workplace, promoting an individual and self-driven work ethic online may improve career readiness. Many education disciplines have indicated no difference or positive impacts when using online options for learning course material (Larson & Sung, 2009; Mullen, 2020; Neuhauser, 2002; Paul & Jefferson, 2019). However, this has not been extensively evaluated in the college of agriculture. Therefore, our objective was to retrospectively collect data on a core Animal Science course, without a laboratory component, to determine equitability of student success in both modalities. We hypothesized that there would be no difference in the academic performance of students enrolled in either online or face-to-face (**F2F**) sections.

Methods

The research conducted here-in was exempt from IRB oversight (IRB2024-292). The *Principles of Nutrition* course, a non-lab associated junior-level core animal science (**ANSC**) course, was selected for analysis. The *Principles of Nutrition* course is a required course for all ANSC students and a pre-requisite course for veterinary school applicants, but also serves as an elective course for any major. Course content exams and instructor of record were not changed for 9 semesters (Fall, Spring, and Summer) beginning in the Spring of 2019 and ending in Fall of 2022. Spring 2020 data was excluded, even though this course was available online prior to the global pandemic of 2020. Pre-requisite courses for *Principles of Nutrition* were *General Animal Science* (a freshman level entry course) and *Chemistry I* (freshman level chemistry).

Instructional Context

The traditional F2F *Principles of Nutrition* course met for three 50-minute lecture periods for the duration of the 16-week regular semester in the Fall and Spring semesters. The online version of the course was asynchronous during long summer or Fall semesters. Although the online sections were asynchronous, unit deadlines were consistent with the pace of the F2F sections of the course. Both F2F and online sections had access to course content through the university Blackboard platform with a mandatory syllabus quiz. The syllabus quiz included questions about instructor office location and meeting times as well as major deadlines and expectations for the course. For online students, the syllabus quiz also utilized the online proctoring chrome browser plug-in technology "Proctorio," to ensure students had the proper equipment and knew how to use the plug-in prior to taking exams online.

The course content included 4 units of study covering (1) basic gastrointestinal anatomy and physiology, (2) structure and function of carbohydrates and glucose metabolism, (3) structure and function of lipids and protein, and (4) structure and function of vitamins and minerals, and most common metabolic disorders. Each unit of study was structured with 2 to 3 learning modules that were associated with module self-assessments and a unit quiz prior to the major unit exam. Four major exams of equal weight were issued, and each exam consisted of 60% of true/false or multiple-choice questions, 20% short answer, and 20% essay. The short answer and essay were graded by the principal investigator according to an internal rubric for equitability across students and terms. There were forty, true/false and multiple-choice questions which were low-stakes questions worth equal weight (1.5 pts each). Short answer questions, 20 pts in total, were high-stakes questions divided into 3 or 4 multi-part questions with full points awarded for using key words and having clear comprehension, half – credit for using key words but unclear comprehension, and no points awarded for no comprehension. The essay was 20 pt, four-part, question with equal weight assigned to (1) a labeled diagram of a gastrointestinal tract, (2) description of digestion of a selected nutrient, (3) key enzymes and their site of secretion, and (4) key end-products of digestion and their site of absorption. The grading rubric for this section was a 5 pt scale for each part with 0 pts being awarded for no work shown, and 5 pts awarded for all key components shown. In the last unit, the 20 pt essay question was divided into two case studies of metabolic disease diagnosis of 10 pts each. Each case study was graded using a similar rubric as the previous exam essay questions for (1) appropriate diagnosis, (2) etiology of the disorder, (3) appropriate treatment of the disorder, and (4) prevention methods for the disorder. Both modalities were equipped with a discussion board for each unit of study and monitored by the instructor. Only the student unit exam data was collected over 9 terms, and the academic performance was interpreted from the mean of the formal unit exam scores.

Data Filtering and Descriptive Characteristics

A total of 749 data points were collected. Students with incomplete or missing exams, tagged for online collusion, labeled as having under-class status (freshman and sophomore status), and any second undergraduate degree status were eliminated from the data sample for a final dataset of 609 data points. The final dataset included 5 online sections (n = 207) and 5 F2F sections (n = 402; Table 1). The F2F enrollment count was 359 and 43 students for ANSC and non-ANSC students, respectively. The online enrollment count was 169 and 38 students for ANSC and non-ANSC students, respectively. There were 394 students classified as juniors and 215 students classified as seniors. A total of 24 majors were represented in the data set: 528 ANSC, 22 Ag Education, 12 Natural Resource Management, 11 Biology, 8 Food Science, 5 Ag Economics, 3 Ag Communication, 3 Interdisciplinary Studies, 2 Ag Business, and singlets from Communications, Health Science, Honors Sciences and Humanities, International Agriculture, Kinesiology, Management, Marketing, Plant and Soil Science, Psychology, Sociology, Spanish, Sports Management, Social Work, and Interdisciplinary STEM.

Table 1

Data count and characteristics

	Modality				
	F2F		Online		Total
Major	JR	SR	JR	SR	
ANSC	261	98	110	59	528
non-ANSC	16	27	7	31	81
	402		207		609

F2F = face-to-face regular course meetings; JR = junior classification; SR = senior classification; ANSC = Animal Science.

Statistical Analysis

Data analysis of academic performance was performed in JMP Pro version 16.0.0 (SAS Institute Inc., Cary, NC). Mean exam scores were not normally distributed, as evidenced by the Shapiro-Wilks goodness-of-fit test where $P < 0.001$. A generalized regression model with a Poisson distribution was selected, and the log link function was used to transform the data and compare least squared means for the fixed factors of modality (F2F or online), major (ANSC or non-ANSC), and their interaction. Differences in the Chi-square probabilities were considered significant when $P < 0.05$, and tendencies were considered when P was > 0.05 but ≤ 0.10. There was no interaction ($P = 0.561$) of modality and major, and so the interaction was removed from the model. For meaningful interpretation of the data, it was determined that a one-way ANOVA could be reported on each of the fixed variables, and the Kruskal-Wallis Rank Sums test was used to compare the exam means.

Results and Discussion

The distribution of each population of students is shown in **Figure 1**. Despite differences in population sample sizes, there were no differences in data variance ($P = 0.295$). Mean academic performance scores were between 84.5% and 87.7%, and the median academic performance scores were between 86.0% and 88.9%.

There was a significant ($P = 0.025$) effect of modality on academic performance (**Table 2**). Students enrolled in online sections had greater mean academic performance scores than students in F2F sections (86.2% vs. 84.6%, respectively). Therefore, we reject the null hypothesis that there is no difference in course academic performance between F2F and online learning. From a letter grade standpoint, both outcomes still result in a letter grade of "B" or 3.0 on traditional 4.0 grading scales. However, since our analysis only included one course, this merits further discussion, since other courses may have different grade distributions and may span letter grades.

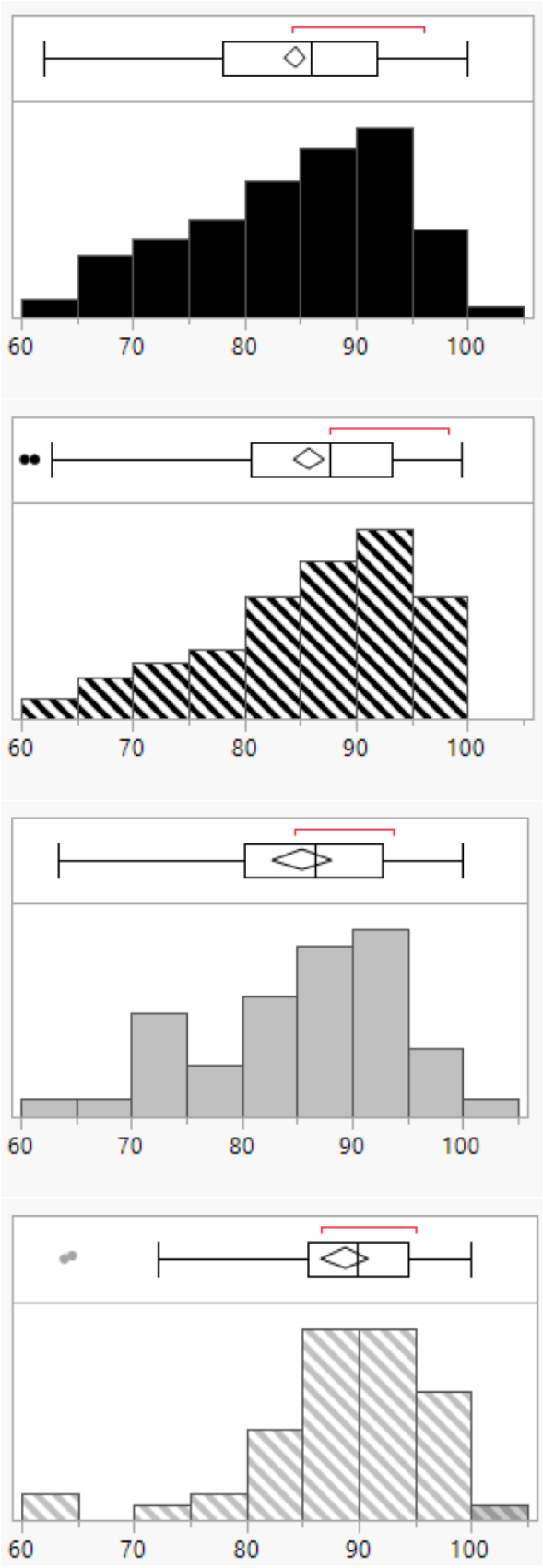
Bigelow (2009) found no effect of modality on student performance in a Turfgrass Science Course case study using a similar grading scale. That study used the overall course grade including formal and informal assessment rather than just formal assessments, as we have, and reported from a single semester with a smaller sample size. In another study, no difference in exam outcomes were observed for an animal anatomy laboratory held F2F or online for two semesters (Bing et al., 2011). However, in another more recent study across courses, Neu et al., (2017) found that student final grades were greater for online sections than F2F in a freshman-level companion animal nutrition class but in a sophomore-level horse management class final grades were either not different or were better for students in F2F than online sections. Interestingly, a difference arose in the student rating of teaching (**SRT**) between the F2F and online horse management course: the SRT for "The instructor provided feedback intended to improve my course performance" was greater for F2F than online. This finding highlights an important aspect of the student-professor relationship and F2F discussions that may affect student motivation or foster deeper understanding for some courses. These findings also highlight an important consideration for administrators: Online instruction may not be a one-size-fits all solution for capacity issues. Significant planning and training may be required for professors to accomplish equitable quality of instruction across both online and F2F modalities to ensure student success. Administrators who encourage online section adoption should equip instructors with the necessary resources for successful course preparation well in advance. Overall, in the current study, the effect of modality was interpreted by the authors to mean that, when courses are well designed, online learning can be a valuable tool for departments facing classroom capacity limitations, without sacrificing student success and academic performance.

There was no effect of major on academic performance ($P = 0.205$). Non-ANSC students had a mean exam score of 86.3%, and the ANSC students had a mean exam score of 85.0%. When (Neu et al., 2017) compared pre- and post-test gains of ANSC and non-ANSC students where ANSC were prioritized into F2F sections, they found no difference in student gains. This outcome agrees with our hypothesis that ANSC students could be prioritized in F2F sections when capacity is limiting and where crucial major specific opportunities and faculty relationships are important.

There are several considerations to be made for each modality prior to launching online sections of animal science courses. Online learning offers flexibility and convenience, allowing learners to access educational content from anywhere with an internet connection. However, the effectiveness of online learning depends on factors such as self-discipline, motivation, and access to resources. Studies in agricultural science courses have shown that well-designed online courses can lead to comparable learning outcomes to traditional F2F instruction (Bigelow, 2009; Bing et al., 2011; Neu et al., 2017). Online learning often fosters self-directed learning skills as learners navigate through digital resources and engage in independent study (Paechter & Maier, 2010). A major benefit to the student is the immediate feedback and tracking of course progress; however, there are limitations specifically for demonstrated skills. In scenarios where the learning objectives are tactile skills, students prefer F2F, where the skills are developed together with instructor oversight (Paechter & Maier, 2010). Animal science courses may have laboratory components where hands-on learning is required to develop skills necessary that qualify them for industry careers. Alternative online strategies using artificial intelligence that mimic laboratory modules are well on their way to the classroom, but currently there is no replication for students to practice and develop these skills across a diverse curriculum like animal science. For ANSC courses with significant hands-on laboratory components a blended "hybrid" model could be adopted to capitalize on the benefits of both the convenience of online learning and the skill building of laboratory components (Ananga & Biney, 2017), while efficiently utilizing classroom space.

Figure 1

Distribution of each student population of students



ANSC F2F	
N =	359
Mean, %	84.5
Std Dev, %	9.09
Max, %	100.0
Q3, %	91.9
Median, %	86.0
QI, %	78.0
Min, %	62.0

ANSC On-Line	
N =	43
Mean, %	85.2
Std Dev, %	8.72
Max, %	97.2
Q3, %	92.4
Median, %	86.5
QI, %	79.8
Min, %	63.4

non-ANSC F2F	
N =	169
Mean, %	85.8
Std Dev, %	9.10
Max, %	99.5
Q3, %	93.1
Median, %	87.7
QI, %	80.6
Min, %	60.3

non-ANSC On-Line	
N =	38
Mean, %	87.7
Std Dev, %	8.22
Max, %	98.3
Q3, %	94.4
Median, %	88.9
QI, %	84.4
Min, %	63.8

Distribution of academic performance (mean, exam percentage) of Animal Science and non-Animal Science majors enrolled in either face-to-face (F2F) or online modalities of a core Animal Science course.

Table 2

Effect of modality and major on content mastery

	Modality		SEM	*P*-value
	F2F	Online		
Content Mastery %	84.6[b]	86.2[a]	0.626	0.025
	Major		SEM	*P*-value
	ANSC	non-ANSC		
Content Mastery %	85.0	86.3	1.00	0.205

[a-b] Values are least squared means without a common superscript differ at P<0.05. P-value is from the Kruskall-Wallis rank sum test.
F2F = face-to-face regular course meetings.
ANSC = animal science

Summary

Enrollment growth does not have to be a capacity nightmare if we think outside of the brick-and-mortar box. Here, we have demonstrated that online modality can be a tool for dealing with increased enrollment without sacrificing quality of learning in core animal science courses. Students performed better online than in the F2F sections, regardless of major, albeit still achieving the same letter grade. Therefore, we conclude that if student seats in the animal and food science department are a constraint, the department may prioritize their ANSC majors for F2F sections and create alternative sections that are either online or a hybrid modality for non-majors. Educators and institutions can leverage the strengths of both modalities through blended learning approaches, combining online resources with F2F interactions to preserve continuity of quality education in Animal Science.

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