

An Empirical Analysis of Agricultural College Students’ Perceptions of Virtual Learning

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The sudden shift in course delivery methods during the pandemic to virtual instruction impacted students in various ways. Previous research lacks information about perceptions of, or preferences for, virtual learning among students with different demographic backgrounds, academic disciplines, and stages of study. This study uses an in-depth conditional Logit statistical procedure to understand these impacts on agricultural students’ perceptions of virtual learning. The findings reveal students believe significant challenges exist with virtual instruction, a positive attitude toward virtual learning leads to improved enrollment in virtual courses in future semesters, and being in control of learning impacts modality preference.

Keywords: agricultural students, empirical analysis, perceptions, preferences, virtual learning

INTRODUCTION

In the middle of the spring 2020 term, the COVID-19 pandemic disrupted higher education, and many academic institutions decided to switch to virtual instruction using the Zoom application. For this sudden transition, faculty were given considerable “flexibility” to teach their courses. Based on their online teaching knowledge and skill set, faculty used different forms of virtual teaching, ranging from fully synchronous to fully asynchronous instruction and something in between. This study is based on virtual learning with synchronous Zoom class meetings rather than a more typical self-paced, web-based online learning environment employed during the semester. For many students, virtual learning was an unfamiliar

learning environment compared to a traditional face-to-face classroom. However, other students, especially those who have taken online courses before, appeared to transition more quickly to a virtual learning environment. In response, academic institutions encouraged faculty to empathize with students and the challenges they were experiencing to ensure that a high level of learning could continue and that students would stay on track to successfully obtain their degrees.

In response to student's challenges and frustrations during the pandemic, some instructors incorporated rapid developments in online pedagogy to become innovative in designing and delivering a positive learning experience. For example, some courses were taught as a hybrid of face-to-face with online synchronous sessions to accommodate varied student teaching modality preferences, while still creating an effective learning environment. However, pedagogy innovations are impossible if institutions do not "take the pulse" of students frequently and analyze the results. It is important to remember the students served by higher education today are very different from those of generations past. As the world begins to recover from the effects of the pandemic, student expectations of the system will continue to change, and the system must adapt. This study was an effort to "take the pulse" of college students during a transition in education. Specifically, this study; 1) identifies factors that affect students' preferences about online learning versus face-to-face learning, 2) quantifies the impact of each factor on learning choices, and 3) discusses potential reasons behind their learning preferences. As COVID-19-related restrictions are lifted, many institutions are trying to form new policies regarding online learning. The findings of this study may help academic institutions identify areas of pedagogical training for instructors and broaden their understanding of what motivates students to learn under various circumstances.

LITERATURE REVIEW

The COVID-19 pandemic emerged rapidly, continued to evolve, and led to social restrictions worldwide. It pushed millions of college students worldwide into a virtual learning setting. The abrupt change in learning modality from face-to-face to virtual instruction had a notable impact on students in different ways. The current literature investigating the impacts of switching to virtual learning brought on by the pandemic has focused on college students' physical activities, dietary habits, sleep issues, mental health, and academic learning.

Physical Activities

The transition to virtual learning resulted in many challenges to college students' physical activities due to increased digital device use and sedentary behaviors. Several studies assessed people's physical activities during the pandemic in various ways. Sidebottom et al. (2021) investigated 403 college students and found that virtual learning students significantly decreased physical activity and increased sedentary behavior. Coughenour et al. (2020) found that the average number of minutes of physical activity significantly decreased after declaring the global pandemic. Huckins et al. (2020) used smartphones to track how college students' physical activities changed pre- and post-COVID-19 and found students tended to be less active. Tison et al. (2020) studied the impacts on worldwide physical activity by examining step count changes. They investigated 455,404 users from 187 countries using daily step counts from smartphones and found steps decreased worldwide during the onset of the pandemic. Another study also highlighted that different groups of college students had different responses to COVID-19 and its consequences, finding that Asian students were more likely to decrease physical activity compared to White students after stay-at-home orders were enacted (Coughenour et al., 2020).

Dietary Habits

Students' dietary habits also significantly changed, with increased meals eaten at home and a decrease in overall fruit consumption (Sidebottom et al., 2021). More students also reported an increase in their use of alcohol or cannabis during the pandemic, 13% and 24%, respectively (Schepis et al., 2021). Additionally, food insecurity affected college students during the pandemic. Some students have been deprived of the free meals universities provide, which can further pose health challenges (Hagedorn et al., 2022).

Sleep Issues

Several studies found that college students' sleep quality and behaviors were negatively affected by virtual learning (Lewis, 2020; Son et al., 2020; Benham, 2020; Wright et al., 2020). A recent study by Zhang et al. (2021) showed students experienced insomnia and other sleep problems. They surveyed 146,102 college students from 22 colleges/universities in China during COVID-19 and assessed depression, anxiety, and sleep-related problems. Analysis of the survey data revealed 16.9% of students had insomnia, 6.3% displayed probable clinical insomnia, and unrefreshing sleep was the top sleep problem among college students during COVID-19. Other studies (Li et al., 2020; Lin et al., 2020; Zhou et al., 2020) reported that age, gender, residence location, perceptions of COVID-19, and psychological factors also affect sleep quality. Lin et al. (2020) found the prevalence of insomnia in people who were female, young and lived in the pandemic epicenter. Benham (2020) studied 1,222 students, 94% of whom identified as Hispanic. Results showed that although stress levels, sleep quality, and the incidence of insomnia were not significantly impacted during the COVID-19 pandemic, bedtime and wake time were significantly later, and sleep duration was significantly longer. Zhou et al. (2020) assessed insomnia, depression, and anxiety symptoms among 11,835 young people, finding that insomnia symptoms occurred in 23.2% of the participants during the COVID-19 epidemic. The study also revealed; 1) insomnia was more severe in females and people residing in cities, 2) depression and anxiety increase the risk for insomnia symptoms, and 3) social support is protective against insomnia symptoms. Lin et al. (2020) also confirmed a high prevalence of insomnia in college students. This could be attributed to different reasons, such as economic stress, social distance restrictions, travel restrictions, or changes in daily life. In addition, international students living outside the United States had to adjust to different U.S. time zones while participating in online synchronous courses, which presented additional virtual learning challenges as these students must adjust their sleep cycle to attend lectures. These altered regular sleep patterns affect the body's circadian rhythm or internal biological clock.

Mental Health

Some college students struggle with psychological challenges. For example, the inability to create a learning environment free of distractions or to develop the organizational skills necessary to complete assignments, projects, and exams on time may increase anxiety levels. Several studies investigated the impact of the COVID-19 pandemic on students' mental health. Schaeffer and Rainie (2020) reported young adults in the 18-29 age group were more prone to mental health issues due to social isolation and financial crises. Cao et al. (2020) showed that college students developed increased levels of depression, anxiety, and suicidal risk during the pandemic. A study conducted by Herold et al. (2021) reported that 65% of students had increased stress levels and 57% exhibited a decreased ability to focus. Patsali et al. (2020) studied 1,104 female and 431 male college students and reported all participants experienced increased anxiety due to social restrictions. The study also revealed females were at a higher risk of depression than males, and isolation had a higher impact on students in the technical sciences, arts, literature, and education when compared to those in the health and biological sciences. McLafferty et al. (2021) conducted a study of 884 college students from two universities in Ireland and found depression levels increased significantly in 2020 compared to 2019, while suicide risk remained high before and during COVID-19.

Academic Learning

Research shows both students and faculty were unprepared for the sudden shift to virtual learning at the beginning of the COVID-19 shutdown (Garrett et al., 2020), and the unexpected shift presented enormous challenges for students concerning their academic learning. Based on a national survey of undergraduate students during the pandemic, 51% of students were very satisfied with their coursework before the pandemic. Still, only 19% of students were very satisfied with their online course experience after moving fully online (Means, et al., 2020). The authors also reported that students experienced reduced learning, conscientiousness, engagement, and frustration during virtual learning. Another study by Aguilera-Hermida (2020) found that students' learning motivation, self-efficacy, and cognitive engagement decreased after the transition. The study reported the quick shift to virtual learning led students to rely on

computer and internet technology to complete coursework. But it is important to recognize students who do not have access to digital learning tools or have technical issues face additional pressures. Sage et al. (2021) studied students' technology choices, experiences, and perceptions in the COVID-19 virtual classroom. They found both laptops and smartphones are important to students' virtual learning, but laptop use led to increased feelings of isolation and stress and lower grades compared to smartphone use. The pandemic also posed a big challenge to foreign students since many countries restricted travel and immigration. A study by Quacquarelli (2020) found that 47% of students dropped their plans to study at foreign universities.

The studies reviewed here focused on the impact of COVID-19 on college students' lifestyles, physical activities, mental health, and academic learning. However, there is little knowledge regarding how students perceived virtual learning during the pandemic or the satisfaction with, or preference for, virtual learning among students from different demographic backgrounds, academic disciplines, and stages of study (freshman, sophomore, etc.). This study adds to existing knowledge by using a unique modeling approach.

METHODS

As the rate of COVID-19 infections exploded in the United States, the need to protect society from infection, possible death, and unknown long-term effects became paramount. At the same time, society recognized that education could not stop altogether because students would fall behind in their academic development. Thus, all levels of education responded by abruptly moving to virtual instruction. For this study, a survey instrument was created in April 2020 to gather college students' opinions about virtual learning during the pandemic. The university where the survey was implemented has nearly 55% Hispanic enrollment, and 70% of the students are the first in their families to attend college. Faculty volunteers in the College of Agriculture were solicited to sample students at various stages of their degree programs (freshman to seniors) and to sample required courses from multiple disciplines within the college. Students were informed that participation in the survey was voluntary and that no bonus points or grade incentives would be provided. Care was taken to avoid surveying students in classes typically taken concurrently during a semester within a discipline to minimize the chance of students taking the survey more than once. Students were also reminded not to repeat the survey if they had completed it in another course. The survey was administered using Qualtrics during the final three weeks of the spring and fall 2020 semesters.

The format of the survey consisted of three sections. First, academic (major, GPA, year in college, etc.) and demographic (age, ethnicity, gender) information were collected. Second, students were asked to use a four-choice Likert scale to indicate their level of agreement with statements in three categories: 1) the overall experience with virtual learning, 2) the perceived positive impacts of switching to virtual learning, where each phrase started with "Virtual learning helped me to . . ." and 3) the perceived problems caused by switching to virtual learning. The four-choice Likert scale presented to students was; strongly disagree = 1, disagree = 2, agree = 3, and strongly agree = 4. Third, students were allowed to respond to three open-ended questions.

This study reports the results of two analyses: 1) the descriptive statistics for the respondents along with mean values for their level of agreement with the statement categories described above, and 2) a Logit analysis of students' plans to enroll for the coming semester if classes are expected to be taught as virtual or in-person. The mean analysis relied on survey section two, which asked students to quantify their level of agreement with multiple statements about virtual learning using the four-choice Likert scale. This section of the survey initially asked students to indicate their level of agreement with four statements reflecting their general enthusiasm and motivation for the virtual learning environment. Then, students were asked to rank their level of agreement with two sets of eleven statements describing how switching to virtual learning impacted their learning in a positive (statement set one) or a negative way (statement set two). These statements involved eleven standard classroom components/tasks encountered in a learning environment, such as communicating with peers and the instructor, studying for examinations/quizzes, expressing ideas/opinions, etc. Statement set *one* focused on whether virtual learning enhanced the components and

statement set *two* focused on whether it created problems in attaining them. The two statement sets allowed for a consistency check in student responses.

The second analysis was a conditional Logit model consisting of a double process. This model was designed to measure the impact of specific attributes of virtual learning on: a) students' preferences for a virtual or in-person learning environment, b) their overall experience with virtual learning, and c) the perceived problems caused by switching to virtual learning.

When choosing a virtual course, students optimize their utility (satisfaction) of learning by pursuing instructional technologies that benefit them the most. According to Lancaster's random utility theory (1966), the utility of the i th learner U_i ($i=1, \dots, I$) derived from the j th alternative of virtual classes (out of a choice set of C) is a function of the selected attributes of the alternative j :

$$U_{ij} = \beta x_{ij} + \varepsilon_{ij} \quad (1)$$

where β is a vector of unknown parameters of interest, x is a vector of selected attributes of virtual class j selected by student i , and ε is a stochastic error term resulting from measurement errors. Previous studies have applied this utility model to estimate students' learning preferences (Xu, 2019; Xu & Lone, 2020).

According to McFadden (1974), the probability P_{ij} that individual i will choose alternative j from the choice set C is the probability that the utility associated with choice j is greater than the utility associated with all other k choices in the same set. Thus,

$$\begin{aligned} P_{ij} &= P(\beta x_{ij} + \varepsilon_{ij} > \beta x_{ik} + \varepsilon_{ik}) \\ P_{ij} &= P(\varepsilon_{ij} - \varepsilon_{ik} > \beta x_{ij} - \beta x_{ik}), j \neq k \end{aligned} \quad (2)$$

Assuming the error terms are independent and identically distributed with the Weibull (Gnedenko, extreme value) distribution (McFadden, 1974), the probability P_{ij} is:

$$P_{ij} = \frac{\exp(\beta x_{ij})}{\sum_{k=1}^j \exp(\beta x_{ik})} \quad (3)$$

In the above conditional Logit model, x represents selected attributes of virtual classes along with the responding students' preferences for those specific attributes. The model assumes that these responding students' characteristics are the same across the sample.

FINDINGS

Demographic Analysis

Table 1 presents the academic and demographic information of the respondents. A total of 449 students completed the survey, with 272 doing so in spring 2020 and 177 in fall 2020. Academically, most were juniors (39.9%) and seniors (27.9%), and most of them (70.4%) had GPAs in the 3.00 – 4.00 range. Agricultural business (60.6%) represented the majority of the respondents, followed by enology/viticulture (12.7%), animal science (5.1%), agricultural education (4.0%), and plant science (3.6%). Twelve percent of the students planned on graduating in 2020, over one-third anticipated graduating in 2021 (34.8%), and the remainder in 2022 or later (48.7%). When queried about plans to enroll the following semester depending on the expected mode of instruction, approximately three-quarters planned to attend if classes were offered face-to-face (76.6%) or virtual (73.3%). More males (52.4%) than females (47.0%) completed the survey, and students less than 20 years of age were the largest group (24.0%), followed by 23+ years (23.4%), and 20 years (21.2%). Ethnically, 46.1% were Hispanic, 45.6% white, and 4.2% Asian. Slightly less than fifteen percent had no work experience, 33.3% had two to three years, and nearly 36% had more than four years.

TABLE 1
DEMOGRAPHICS & ACADEMIC STANDING

Survey Variable	Count	%	Survey Variable	Count	%
<u>Gender</u>			<u>Graduation Status</u>		
Female	211	47.0	Freshman	63	14.0
Male	235	52.4	Sophomore	68	15.1
Other	1	0.2	Junior	179	39.9
Missing	2	0.4	Senior	125	27.9
Total	449	100.0	Graduate Student	14	3.1
			Total	449	100.0
<u>Age</u>			<u>Estimated GPA</u>		
Less than 20	108	24.0	1.00 – 1.99	1	0.2
20	95	21.2	2.00 – 2.99	105	23.4
21	83	18.5	3.00 – 4.00	316	70.4
22	58	12.9	Not Sure	25	5.6
23+	105	23.4	Missing	2	0.4
Total	449	100.0	Total	449	100.0
<u>Ethnicity</u>			<u>Year of Graduation</u>		
American Indian	7	1.6	2020	54	12.0
Asian	19	4.2	2021	156	34.8
Black/African American	4	0.9	2022	125	27.8
Hispanic	207	46.1	2023	79	17.6
White	205	45.6	2024	15	3.3
Other	7	1.6	Not Sure	20	4.5
Total	449	100.0	Total	449	100.0
<u>Work Experience</u>			<u>Predominant Majors</u>		
None	65	14.5	Agricultural Business	272	60.6
1 Year	73	16.3	Enology & Viticulture	57	12.7
2 - 3 Years	150	33.3	Animal Science	23	5.1
4 - 5 Years	88	19.6	Agricultural Education	18	4.0
6+ Years	73	16.3	Plant Science	16	3.6
Total	449	100.0	Other	48	10.7
			Missing	15	3.3
			Total	449	100.0

Mean Analysis

The mean values and standard deviations for students' overall experiences with virtual learning appear in Table 2. None of the four statements in this category received a mean value above 3.00, indicating respondents generally agreed, as values ranged from 2.67 to 2.28. However, it is essential to note the large standard deviations (SD) associated with statements in this category (0.86 to 0.92) and the other two categories, which indicate large dispersions around the reported means. For this particular statement category, students did not view virtual learning as easy to use, helpful in learning, or enjoyable, nor would they recommend using it in other classes. Not surprisingly, responses for this category of statements and the other two categories described below were more favorable during the fall 2020 semester. A plausible explanation stems from the fact that during the spring 2020 semester, students used virtual learning for

approximately one-half of the semester versus the entire fall 2020 semester. Thus, spring 2020 students had little time to adjust to a virtual learning environment. Having spent part of the spring semester online, combined with spending the next semester entirely online allowed them to become more familiar and comfortable with, and adaptive to, the virtual learning environment. Further, the levels of agreement with all of the statements in the survey are influenced by several factors, such as individual student preferences for a particular learning modality, student motivation levels and willingness to adapt, the ability of faculty to transition to a virtual environment, etc. Given that these factors could impact the Likert value chosen, mean responses between the two semesters that were statistically different are noted by an asterisk in the results tables.

TABLE 2
MEAN VALUES FOR OVERALL EXPERIENCE WITH VIRTUAL LEARNING

Survey Statement	Count	Overall Mean	Std. Dev.	Spring 2020	Fall 2020
Virtual learning was easy to use.	447	2.67	0.86	2.60	2.78
Virtual learning was useful for my learning.*	446	2.33	0.90	2.24	2.46
I have enjoyed using virtual learning in my course.*	449	2.33	0.91	2.25	2.46
I would recommend virtual learning for use in other classes.*	449	2.28	0.92	2.20	2.41

*Indicates significance at the 0.05 level

The mean values for the eleven statements about how virtual learning helped students appear in Table 3. Mean values ranged from 2.98 to 2.06 (SD 0.87 to 0.94). The statement with the highest mean value of the agreement was “Virtual learning helped me to attend class sessions remotely” (2.98), falling just shy of the general agreement mean of 3.00. The next highest mean value was for the statement, “Virtual learning helped me to be in control of my learning in the course” (2.73). The mean values for six of the eleven statements were generally closer to ‘agree’ (3.00) than ‘disagree’ (2.00). Students tended to disagree that virtual learning helped them feel a sense of community/social presence in class (2.06), aided in collaboration with classmates (2.28), helped them communicate with classmates (2.28), helped them express themselves in new/creative ways (2.34), or helped improve their overall learning in the course (2.34).

When evaluating the statements regarding the perceived problems caused by switching to virtual learning (see Table 4), mean values ranged from 2.66 to 3.09 (SD 0.82 to 0.93). For this statement category, students tended to agree or be closer to agreement with each statement. The four statements that students agreed with (mean \geq 3.00) were that virtual learning reduced communication (3.09), collaboration with classmates (3.07), detracted from a sense of community and social presence in the course (3.05), and increased the difficulty learning course materials/content (3.03). Students generally agreed more than disagreed that virtual learning presented additional challenges to learning (2.98), made it more difficult to express themselves and their ideas in new/creative ways (2.86), reduced communication with the instructor (2.84), and made more efficient use of their time (2.75). In general, the mean values in Table 4 indicate students did not believe the virtual learning environment that was thrust upon them positively impacted their learning.

TABLE 3
MEAN VALUES FOR HOW VIRTUAL LEARNING HELPED

Survey Statement	Count	Overall Mean	Std. Dev.	Spring 2020	Fall 2020
Virtual learning helped me to attend class meetings remotely.*	445	2.98	0.87	2.89	3.11
Virtual learning helped me to be in control of my learning in the course.*	446	2.73	0.89	2.63	2.89
Virtual learning helped me to communicate with my instructor.	445	2.66	0.86	2.61	2.74
Virtual learning helped me to make efficient use of my time in the course.*	447	2.64	0.94	2.50	2.86
Virtual learning helped me to study for quizzes/exams.*	444	2.63	0.90	2.54	2.78
Virtual learning helped me to learn the course materials/content.*	445	2.52	0.90	2.44	2.65
Virtual learning helped me to improve my overall learning in the course.*	442	2.34	0.91	2.21	2.54
Virtual learning helped me to express myself and my ideas in new and creative ways.	432	2.34	0.89	2.27	2.45
Virtual learning helped me to communicate with my classmates.	443	2.28	0.88	2.24	2.35
Virtual learning helped me to collaborate with my classmates.	440	2.28	0.89	2.24	2.33
Virtual learning helped me to feel a sense of community and social presence in my course.	441	2.06	0.91	2.03	2.12

*Indicates significance at the 0.05 level

TABLE 4
MEAN VALUES FOR PROBLEMS CAUSED BY VIRTUAL LEARNING

Survey Statement	Count	Overall Mean	Std. Dev.	Spring 2020	Fall 2020
Virtual learning reduced communication with my classmates.	441	3.09	0.84	3.10	3.07
Virtual learning reduced collaboration with my classmates.	439	3.07	0.84	3.13	2.98
I do not feel a sense of community and social presence in my course.	441	3.05	0.84	3.09	2.99
Virtual learning increased the difficulty of learning the course materials/content versus face-to-face meetings.*	442	3.03	0.88	3.15	2.85

Survey Statement	Count	Overall	Std. Dev.	Spring 2020	Fall 2020
Virtual learning presented additional challenges to my overall learning in the course.*	443	2.98	0.86	3.13	2.74
Virtual learning made it harder to express myself and my ideas in new and creative ways.	426	2.86	0.82	2.92	2.78
Virtual learning reduced communication with my instructor.	444	2.84	0.88	2.82	2.87
Virtual learning increased the difficulty of getting help for quizzes/exams.*	441	2.82	0.90	2.94	2.63
Virtual learning increased the difficulty in making efficient use of my time in virtual learning.*	444	2.75	0.91	2.87	2.57
Virtual learning made it more difficult to be in control of my learning in the course.*	444	2.73	0.86	2.82	2.59
I do not like to attend class meetings remotely.	437	2.66	0.93	2.73	2.56

*Indicates significance at the 0.05 level

Logit Analysis

The Logit model's objective was to identify the factors impacting the preference for virtual or face-to-face learning. The model required creating variables representing demographic information and students' opinion ratings for the statements about the virtual learning experience. Identifying the opinion-rating variables that impact preferences were determined using a double Logit process. For example, four variables were created from the statements in the survey asking students' opinions about their overall experience with virtual learning. Additional variables were created for each statement about how virtual learning helped with or created problems for learning. A first run of the Logit model indicated which variables had the most significant impact on learning preference. Then a second run of the Logit model, including the most significant variables and the demographic information variables, was executed to further identify the impact of the selected variables on learning preference. Table 5 provides the results of the double Logit process, showing the definitions and mean values of the variables that remained in the model. The mean values of these variables demonstrated central tendency and did not skew to include many outliers.

When comparing the mean values of the two sets of statements regarding whether the virtual environment enhanced learning or created problems for learning, students agreed with the opposing statements. For example, students disagreed with the statements that virtual learning helped them communicate and collaborate with classmates and agreed that virtual learning reduced communication and collaboration with classmates.

TABLE 5
VARIABLE DEFINITIONS AND MEANS

Variable Name	Definition Code	Mean	Variable Name	Definition Code	Mean
Semester	1 = fall 2020 0 = spring 2020	0.38	GPA	0 = < 2.00 1 = 2.00 – 2.99 2 = 3.00 – 4.00	1.75
Age	1 = < 20 2 = 20 3 = 21 4 = 22 5 = > 22	2.56	Gender	1 = male 2 = female	1.50
Year	1 = freshman 2 = sophomore 3 = junior 4 = senior 5 = grad. student	2.84	Work Experience	1 = none 2 = 1 year 3 = 2 – 3 years 4 = 4 – 5 years 5 = > 6 years	2.97
Challenge to Overall Learning	1 = strongly disagree 2 = disagree 3 = agree 4 = strongly agree 5 = not applicable	2.98	Reduced Communication with Teacher	1 = strongly disagree 2 = disagree 3 = agree 4 = strongly agree 5 = not applicable	2.84
Self-Control of Learning	1 = strongly disagree 2 = disagree 3 = agree 4 = strongly agree 5 = not applicable	2.69	Collaboration with Peers	1 = strongly disagree 2 = disagree 3 = agree 4 = strongly agree 5 = not applicable	2.32
Feel Community & Social Presence	1 = strongly disagree 2 = disagree 3 = agree 4 = strongly agree 5 = not applicable	2.27			

The Logit model means statistics reported in Table 5 above are not necessarily the same as those reported in Table 4 for two reasons. First, all variables reported in Table 5 are included in the conditional Logit model, and observations with a missing value in any of the selected variables in the Logit model are excluded from the mean computations. Due to the exclusion of these observations, the mean statistics may differ from those that were reported in Table 4. Second, this model does not differentiate the mean statistics by the data collection semester. Thus, when computing the mean statistics in the Logit model, all observations gathered across both semesters were used.

Logit - The First Model

The first model estimated the impact of various variables on students' preferences for learning environments during the next semester. The dependent variable for the "liked virtual learning" model was coded as 1 if a student answered "Yes" to the question "If you are NOT a graduating senior and courses next fall are expected to be virtual (online) instruction, do you plan to enroll in fall 2020?" and was coded as 0 for a "No" response. For the 'liked face-to-face' model, it was coded as 1 if a student answered "Yes" to the question "If you are NOT a graduating senior and courses next fall are expected to be face-to-face instruction, do you plan to enroll in fall 2020?" and was coded as 0 otherwise.

The estimated coefficients, marginal effects, and test statistics from the Logit model appear in Table 6. Both Logit model estimations have low Prob > chi2 statistics (alpha < 1%), relatively high LR scores, and large log-likelihood statistics. The two models are statistically significant in explaining the relationship between the selected attributes and students' stated learning preferences. In other words, the selected variables have a statistically significant impact on changing students' preferences about virtual or face-to-face classes. Thus, the null hypothesis that there is no statistically significant relationship between the selected demographic variables, the virtual learning via Zoom opinion variables, and the resulting learning preference was rejected.

TABLE 6
PERCEIVED IMPACT OF ZOOM ON LEARNING PREFERENCE

Variable	Liked Virtual Learning			Liked Face-to-Face Learning		
	Coefficient	P > z	Marginal Effects	Coefficient	P > z	Marginal Effects
Semester	0.35	0.37	0.03	-2.10	0.00*	-0.13
GPA	-0.37	0.37	0.03	0.30	0.54	0.01
Age	-0.09	0.51	0.01	-0.04	0.80	0.00
Gender	0.56	0.13	0.05	0.48	0.27	0.02
Year	0.04	0.92	0.00	0.06	0.90	0.00
Work Experience	0.05	0.77	0.00	0.31	0.08***	0.01
Self-Control of Learning	1.09	0.00*	0.10	-0.50	0.08***	-0.02
Constant	-1.01	0.40		3.09	0.05	
Log Likelihood	-115			-79		
LR chi2 (7)	37			34		
Prob > chi2	< 0.001			< 0.001		

*Alpha < 1%, ***Alpha < 10%

One section of the survey asked students to indicate their level of agreement with eleven statements about the perceived positive impacts on their learning when using Zoom. The double Logit process was applied to identify which of the eleven statements (coded as variables) were statistically significant in changing learning. The only statistically significant variable was being in control of their learning. Specifically, students who believe virtual learning gives them control of their learning also perceive the impact of using Zoom on learning as positive. This self-control variable was included with other demographic variables to fit the Logit model. In the 'liked virtual learning' model, self-control of learning showed a positive and statistically significant impact on the decision to take a virtual class in the following semester (alpha<1%). Further, the marginal effect estimate explains that a student who believes that virtual learning via Zoom helps them control their learning is 10% more likely to prefer a class conducted via Zoom.

Interestingly, the self-control of learning variable represented a significant (alpha<10%) but negative impact on choosing a face-to-face class when fitted into the 'liked face-to-face' model. This indicates that students who consider themselves as being better disciplined and can control their learning are more likely to prefer virtual classes (10% more likely) and less likely to prefer face-to-face classes (2% less likely). Additionally, in the 'liked face-to-face' model, work experience was found to have a significant impact on learning (alpha<10%). Students with more work experience tend to be 1% more likely to prefer a face-to-

face class than a virtual class. Previous studies (e.g., Lent et al., 2014; Sheu et al., 2014) have confirmed that cognitive variables such as self-efficacy, meta-cognitive knowledge, and goal progress affect students' learning behavior. For example, Tims, Bakker & Derks (2014) found that students with high levels of self-efficacy take the initiative in learning and enjoy the learning process. Students who believe themselves to have strong self-control of learning would have high levels of self-efficacy. In addition, effective virtual learning requires good time management and organization skills (Davis et al., 2022). Unsurprisingly, students' self-control of learning affects their preferences for learning modality.

The final significant variable in the 'liked face-to-face' model, with a negative sign, was the semester variable ($\alpha < 1\%$). This means that students who participated in the Fall 2020 survey were 13% less likely to prefer the face-to-face option than those taking the Spring 2020 survey. It seems to indicate the sudden switch to online learning in spring 2020, coupled with the uncertainty in course offering options in fall 2020, may have pressed students to choose virtual learning rather than the face-to-face option. In general, this model's results indicate that switching to virtual learning using Zoom changed students' perceptions about taking courses and pressured them to consider learning via Zoom a valuable option.

Logit - The Second Model

The second model considered how the overall experience with virtual learning via Zoom affected students' preferences for virtual versus face-to-face courses. One of the survey sections asked students to rate their overall Zoom experience based on four statements using the Likert scale described previously, and two of the four statement variables in the model showed a statistically significant impact on learning preferences. Specifically, students who enjoyed virtual learning via Zoom and who would recommend Zoom learning for use in another class were more likely to perceive a difference in the two modality options and were more likely to enjoy Zoom classes (see Table 7).

The overall model's goodness of fit showed the selected variables were statistically significant in explaining learning preferences ($P > \chi^2 \text{ statistics} < 0.001$). Additionally, the enjoyed virtual learning variable significantly and positively impacted both learning modalities. Thus, a positive experience with Zoom learning motivated students to choose virtual and face-to-face learning in their future studies. The marginal effect statistics showed that students who enjoyed learning via Zoom were 5% more likely to enroll in a virtual class and 3% more likely to enroll in a face-to-face class the following semester. Furthermore, students who would recommend virtual learning in other classes were also more likely to change their learning preferences. However, the direction of this variable's impact differs for the two modalities. Students who would recommend virtual learning were 5% more likely to take a Zoom class in the following semester but 6% less likely to take a face-to-face class. Finally, the semester variable was the only other variable that had a statistically significant impact on learning preference. The negative impact of this variable indicates that compared to spring 2020, students were less likely to prefer face-to-face classes in fall 2020 ($\alpha < 0.001$). This could be because various information sources were indicating face-to-face classes were less likely to be available in the fall, making students adapt to Zoom classes as a practical alternative. This survey did not ask students about the reasons behind the learning preference change, nor did the survey inquire why students would prefer a Zoom class in fall 2020.

TABLE 7
PERCEIVED OVERALL EXPERIENCE WITH ZOOM VIRTUAL LEARNING

Variable	Liked Virtual Learning			Liked Face-to-Face Learning		
	Coefficient	P > z	Marginal Effects	Coefficient	P > z	Marginal Effects
Semester	0.54	0.17	0.04	-2.15	0.00*	-0.09
GPA	-0.35	0.39	-0.03	0.52	0.33	0.01
Age	-0.10	0.47	-0.01	0.07	0.68	0.00
Gender	0.58	0.11	0.05	0.49	0.30	0.01
Year	0.12	0.75	0.01	-0.15	0.75	0.00
Work Experience	-0.03	0.85	0.00	0.29	0.14	0.01
Enjoyed Virtual Learning	0.57	0.08***	0.05	1.01	0.03**	0.03
Would Recommend Virtual Class	0.62	0.06***	0.05	-2.06	0.00*	-0.06
Constant	-0.63	0.61		4.03	0.01	
Log Likelihood		-116			-68	
LR chi2 (7)		35			57	
Prob > chi2		< 0.001			< 0.001	

*Alpha < 1%, **Alpha < 5%, ***Alpha < 10%

In the final Logit model, the impact of the perceived problems associated with Zoom learning was tested on students' learning modality preferences (see Table 8). The dependent variable was still the binary variable of liked virtual learning (coded as 1 if someone liked virtual learning, 0 otherwise) or liked face-to-face learning (coded as 1 if someone liked face-to-face learning, 0 otherwise). The selection of independent variables was again conducted using the double Logit process which resulted in two significant variables; reduced communication with the instructor and presented additional challenges to my overall learning in the course. This was also confirmed by the Davis, et al. (2022) study which found that students believed the lack of communication and a decrease of overall learning effectiveness were two major challenges of virtual learning. Students who experienced those challenges tended to express a preference for in-person classes.

The model's goodness of fit shows the selected variables were statistically significant in explaining students' change in learning preferences. First, students who perceived difficulty in communicating with the instructor using Zoom were 4% less likely to favor virtual learning but 3% more likely to prefer face-to-face learning. Second, when Zoom was determined to be a challenge to overall learning, students were 9% less likely to choose virtual learning but 1% more likely to select face-to-face learning. The study determined that students who claimed to be hands-on learners and those with poor time management skills found virtual learning very challenging. The findings confirmed that students who believed virtual learning resulted in reduced communication with the teacher and those who believed virtual learning challenged overall learning were more likely to take face-to-face classes. Therefore, a positive virtual learning experience will lead to a preference for that learning modality. Students who favor virtual classes are more likely to recommend virtual classes to other students. Another study by Davis et al. (2022) found that

students' factors, such as learning style and work ethic impacted the perceived challenges of virtual learning.

TABLE 8
PERCEIVED PROBLEMS CAUSED BY SWITCHING TO VIRTUAL LEARNING

Variable	Liked Virtual Learning			Liked Face-to-Face Learning		
	Coefficient	P > z	Marginal Effects	Coefficient	P > z	Marginal Effects
Semester	0.16	0.69	0.01	-1.99	0.00*	-0.10
GPA	-0.26	0.52	-0.02	0.15	0.78	0.01
Age	-0.06	0.67	-0.01	-0.08	0.63	0.00
Gender	0.67	0.08***	0.05	0.62	0.20	0.02
Year	0.30	0.43	0.02	0.05	0.91	0.00
Work Experience	0.09	0.59	0.01	0.29	0.13	0.01
Reduced Communication With Teacher	-0.56	0.03**	-0.04	0.75	0.02**	0.03
Challenge to Overall Learning	-1.20	0.00*	-0.09	0.34	0.27	0.01
Constant	6.76	0.00		-0.96	0.56	
Log Likelihood		-111			-76	
LR chi2 (7)		43			41	
Prob > chi2		< 0.001			< 0.001	

*Alpha < 1%, **Alpha < 5%, ***Alpha < 10%

Third, gender matters. Females were 5% more likely than males to choose virtual learning as a favorable learning modality in the 'liked virtual learning' model. Interestingly, female students were also 2% more likely than male students to prefer face-to-face learning. Thus, compared to male students, female students were more likely to favor either learning modality. Indeed, there appears to be a gender gap in virtual learning. Current literature indicates that gender differences exist in online communication (Walther, 1992) and that women tend to be significantly more likely to express both positive and negative emotions than men (Zhang et al., 2013). Specifically, women were found to be more capable than men in expressing themselves through sentences, phrases, and word levels in online communications (Zhang et al., 2013). Furthermore, a previous study indicated female students might face a higher risk of developing anxiety than male students, creating learning barriers, especially for first-generation female college students (Gao and Liu, 2020). For example, anxiety was heightened during the COVID-19 pandemic when female students faced internet connectivity issues as well as health and financial instability. These barriers make schoolwork more difficult to prioritize, especially for low-income students who are more likely to face such challenges (Gillis and Krull, 2020).

Lastly, the impact of the semester variable was similar to what was found in Table 7. The negative impact of this variable shows that compared to spring 2020, students were less likely to prefer face-to-face classes in fall 2020 (alpha < 0.001). Specifically, compared to spring 2020, students in fall 2020 were 10% less likely to favor face-to-face classes in the following semester.

DISCUSSION AND IMPLICATIONS

The purpose of this study was to provide a data-driven analytical framework to understand the impact of switching to virtual learning (Zoom Classes) during the COVID-19 pandemic on agricultural college students' perceptions of virtual learning as well as their preferences for the virtual learning modality. It represents the first study utilizing a Logit process to analyze students' opinions and demographic characteristics to better understand student learning preferences. This research fills a gap in the existing literature and identifies important factors that affect students' choice of virtual versus in-person learning. It also demonstrates students' quick adoption of online learning during the sudden switch to Zoom and reveals challenges to overall learning when face-to-face learning is unavailable.

Analysis of the survey data affirms that virtual learning is becoming an acceptable option for some agribusiness and agricultural students. It shows that students enrolled in the second semester of virtual classes seem more likely to accept the learning modality. Even though this study did not gather information regarding specific assignment activities that students participated in during virtual learning, it does show the willingness of students to adopt new learning modalities as their experience and comfort levels increase. This finding is consistent with a previous study that pointed out that when agribusiness students become more familiar with new technology associated with virtual learning, they are more likely to accept the new learning format and use it as an efficient tool for college study (Xu, 2020). Further, the study concludes that students who enjoy virtual learning are more likely to take both virtual and face-to-face classes. Students who become more familiar with Zoom-based virtual learning tend to be more confident about their ability to learn virtually and are more likely to view virtual learning as a favorable opportunity. In terms of the type of students who tend to be more interested in virtual learning, the findings suggest that students who believe they have strong self-control of learning are those who prefer virtual learning and are less likely to favor face-to-face instruction. For example, the more students can limit themselves from distractions, the more effectively they can learn on Zoom. These findings suggest it is essential for academic institutions to remember, especially as pedagogy evolves and new learning modalities are conceived, that students may need an adjustment period to boost their familiarity and confidence with a learning modality to achieve the highest potential for success.

LIMITATIONS

This study has limitations. First, the survey data used to compute statistics and estimate the econometric models were gathered from two semesters at one institution. Second, the sample population comprised students from various agricultural disciplines within one college with various learning styles and preferences. Thus, these results may not represent students from other majors. Third, data from opinion surveys may under-report opinions viewed as out of the norm or inappropriate, thus biasing the results. Future studies that gather information from a diverse population and are cognizant of taking steps to minimize factors that potentially bias results would be beneficial to further understanding students' needs and preferences for online learning.

CONCLUSION

This study reveals a group of students more likely to favor virtual learning and less interested in traditional face-to-face learning. Specifically, students who recommend virtual classes to others are more likely to favor virtual classes themselves and are less likely to choose traditional courses. Given that the students in this study are agricultural majors, some of whom have limited exposure to alternative learning modalities in their discipline, the study discovered these students are adjusting to Zoom learning and consider Zoom classes an effective learning option for their future academic studies. This has relevance for institutions as they experiment with new learning environments through pilot courses or programs. In addition to the adjustment period mentioned above, students need to see the value of alternative learning environments, and a positive experience goes a long way toward that goal.

This study also identified there are challenges students face when taking virtual courses. Analysis of the data reveals a lack of motivation for students to learn on Zoom due to the complaint about reduced communication with the instructor, which made it difficult for students to fully participate and attain answers to questions. This demonstrates that students do value interaction with their instructors and peers during virtual courses. Thus, recognizing the importance of student-to-student and faculty-to-student interactions is key to providing effective instruction, whether it is virtual or face-to-face. To improve virtual learning effectiveness, the instructor should develop interactive and enjoyable activities to engage students with the course and peers. For many students, virtual learning has put them in a situation where access to resources is reduced and communication with the instructor and peers is limited. To help students overcome these barriers, instructors may want to consider making themselves more available to improve student accessibility. In addition, faculty need to check on students to find out what is working well and what needs to be adjusted during the semester to identify learning barriers and address them promptly. For example, creating flexible course options, communicating frequently, and setting reachable and clear expectations effectively reduce barriers and aid student success.

This study focused on students' perceptions of how a virtual modality using Zoom aided their learning or presented obstacles to learning. It also considered the importance of academic and demographic elements in influencing their preference for a virtual or face-to-face learning environment. Findings from this study can help educational institutions establish online learning policies and procedures that complement face-to-face instruction. This additional knowledge of students' perceptions of virtual or other learning modalities is important to continually assess the learning process. Higher education institutions have learned that a one-size-fits-all approach, like what students experienced with virtual learning during the pandemic, does not benefit all students. Many factors should be considered as universities contemplate and design effective learning pedagogies for the future. A key challenge for the future is finding a balance of online, face-to-face, or other undiscovered modalities that accommodate the varied preferences of students while providing them with the skill sets and experiences essential for lifelong success.

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