Journal of Postsecondary Student Success 3(3)
doi: 10.33009/fsop_jpss134781

The Effects of Course Modality on Student Satisfaction and Academic Outcomes at a Liberal Arts College During the COVID-19 Pandemic

Suhua Dong*

Gettysburg College

Abstract

Using student self-reports on a survey and objective records of academic achievement, I examined the effects of course modality on student satisfaction and academic outcomes at a selective liberal arts college in spring 2021. I compared three groups of undergraduates (N = 729) based on their predominant course modality: Online-Class Group, Residential Blended Learning Group, and Residential In-Person-Class Group. After controlling for gender, race/ethnicity, class level, and socioeconomic status, course modality demonstrated significant main effects on all three satisfaction variables and sense of connection a student felt to the institution. The Online-Class Group reported the lowest satisfaction with level of academic challenge, quality of teaching, and overall quality of academic experiences; it also reported the weakest sense of connection. The Residential Blended Learning Group differed from the Residential In-Person-Class Group on one variable: satisfaction with quality of teaching, on which the former reported lower satisfaction. Course modality did not affect a student's grade point average; although it interacted with gender in its effect on the number of course units a student passed, no subgroup difference by course modality and gender was significant. This study indicates that online classes and blended learning, especially the latter, have potential at liberal arts colleges.

Keywords: course modality, remote learning, hybrid/blended learning, student satisfaction, academic outcomes, liberal arts colleges

* Contact: sdong@gettysburg.edu

The Effects of Course Modality on Student Satisfaction and Academic Outcomes at a Liberal Arts College During the COVID-19 Pandemic

The COVID-19 pandemic (hereafter the pandemic) posed unprecedented challenges for teaching and learning. In the United States, it led to an abrupt shift from in-person to online instruction in March 2020. During the 2020–21 academic year, to mitigate the impact of the continuing pandemic on the health and safety of their students and employees, colleges de-densified their campus by requiring or incentivizing students to study remotely or take hybrid courses. Based on the Integrated Postsecondary Education System (IPEDS) data (IPEDS, 2023a), in fall 2020, among all U.S., degree-seeking undergraduates at degree-granting, public and private (not-for-profit) four-year or above institutions, only 20.47% were enrolled exclusively in in-person courses; the rest (79.53%) were either enrolled exclusively in, or in some but not all, distance education courses (i.e., online courses). In contrast, in fall 2019, the figures were 65.76% and 34.24%, respectively. This shift in course modality was also prevalent at liberal arts colleges. In fall 2020, among all degree-seeking undergraduates enrolled at U.S. private (not-for-profit) liberal arts colleges, 55.61% were enrolled exclusively in in-person courses; the rest (44.39%) were either enrolled exclusively in, or in some but not all, distance education courses. The figures for fall 2019 were 97.32% and 2.68%, respectively (IPEDS, 2023a).

Although institutions have resumed their normal operations since fall 2021, it is meaningful to reflect upon the impact of this significant shift in course modality on student experience during that forced "experiment" in higher education. To inform future innovations, institutions can benefit from examining empirical evidence gathered during the pandemic, evidence illuminating the variation of student experience depending on their course modality. For institutional researchers at residential liberal arts colleges that had never provided online or hybrid classes during the fall or spring semester, the pandemic presented perhaps a once-in-a-lifetime opportunity to study the effects of course modality on student experience. Further, during the pandemic, a student's course modality was often determined by the institution, not the student's own choice, thus reducing the self-selection bias in research, a goal difficult to achieve during normal times. However, only a limited number of studies have examined how course modality affected student experience and outcomes during the pandemic. Such research would be of particular value to residential liberal arts colleges, as during normal times systematic research on blended or online learning is not even possible.

Postpandemic, nationally, there has been a growing proportion of degree-seeking undergraduates enrolled in online classes or hybrid/blended learning. Among all degree-seeking undergraduates at public or private (not-for-profit) four-year or above institutions, the percentage of those enrolled exclusively in distance education courses has grown considerably compared with the prepandemic year (fall 2019: 11.48%; fall 2022: 17.34%). The percentage of those enrolled in some but not all distance education

courses has notably increased as well (fall 2019: 22.76%; fall 2022: 34.99%; IPEDS, 2023a). This upward trend was also true of private (not-for-profit) liberal arts colleges, which witnessed a considerable increase in the proportion of degree-seeking undergraduates enrolled exclusively in distance education courses (fall 2019: 0.29%; fall 2022: 1.43%), and in the percentage of students enrolled in some but not all distance education courses (fall 2019: 2.39%; fall 2022: 7.16%). In fall 2022, among the 200 private (not-for-profit) liberal arts colleges, the number of institutions with at least five degree-seeking undergraduates enrolled exclusively in, or in some but not all, distance education courses almost doubled compared with the prepandemic year (fall 2019: 49 colleges; fall 2022: 94 colleges; IPEDS, 2023a). It is true that liberal arts colleges offering online or blended learning during the fall or spring semester are mostly less selective institutions. Nonetheless, the trend is noteworthy and seems to indicate the growing importance of online and hybrid offerings at this type of college.

In current challenging times for higher education, it is imperative for institutions to innovate in order to thrive in an increasingly competitive landscape. This study aims to inform innovative thinking at liberal arts colleges. This type of institution is typically highly residential and offers small, in-person classes; liberal arts colleges also tend to put a premium on high-quality undergraduate teaching (in a traditional classroom), and are characterized by small student body, close face-to-face student-faculty and student-to-student interaction, and campus environments where learning occurs both in and outside the classroom. Nowadays, many of them are struggling financially due to declines in enrollment (IPEDS, 2023b) and net tuition revenue (National Association of College and University Business Officers, 2023). Nationally, from 2019–2020 to 2022–23, the 12-month enrollment of full-time, degree-seeking undergraduates at liberal arts colleges declined by 5.53%, as compared to 3.11% at all four-year and above institutions (public and private/not-for-profit combined; IPEDS, 2023b). To be financially sustainable, most liberal arts colleges, if not all, are compelled to think outside the box about their operations, including course offerings. As a way to reduce cost and/or generate additional revenue, some liberal arts colleges may expand their distance education offerings; some may start to experiment with or embrace the online or hybrid model to some degree. It is important for various stakeholders of liberal arts colleges to pay close attention to research investigating the effectiveness of these emerging models.

Even prior to the pandemic, researchers had recommended that future studies analyze the link between course modality and academic outcomes (Sewell, 2016; Thompson & McDowell, 2019; Yen et al., 2018). Given the growth of undergraduates enrolled in online and blended learning and the knowledge gaps in literature, it is critical to conduct more rigorous research to assess the effectiveness of these nontraditional modalities in terms of outcomes. Research using samples of students at liberal arts colleges is especially needed given the apparent lack of literature focusing on this type of institution. Empirical research, such as this study, can help institutions, particularly liberal arts colleges, to identify successes and shortfalls of different course modalities and to be more effective in implementing future online and blended learning.

Literature Review

Prior to the pandemic, a substantial amount of research had been conducted to determine the impacts of course modalities on student experience and learning outcomes. During and after the pandemic, only a limited number of studies were performed measuring the effectiveness of online and hybrid models in terms of student learning, not to mention those focused on liberal arts colleges. Summarized below is the recent work most relevant to the focus of this study: comparisons of student perceptions and academic outcomes by course modality.

Prepandemic Research

In one of the earliest meta-analyses of research on online learning in higher education, Bernard et al. (2004) concluded that, overall, there was no statistically significant difference in perceptions or academic achievement between distance education and the traditional face-to-face education. Similarly, another meta-analytical study (Zhao et al., 2005) also observed that "the aggregated data of available studies show no significant difference in outcomes between distance education and face-to-face education as previous research reviews suggest" (p. 1836). Some of the later studies (e.g., Bowen et al., 2012; McCutcheon et al., 2015; Woltering et al., 2009) yielded largely similar findings. Woltering et al. (2009) compared satisfaction and learning outcomes of two groups of third-year medical students: those enrolled in a blended learning course and those in a traditional (i.e., face-to-face/in-person) course. They found no difference in terms of objective test results, and the blended learning group reported higher satisfaction. Another example was a rigorous study by Bowen et al. (2012) who measured the effect of course modality on learning outcomes by randomly assigning students from six public universities to take a statistics course in a hybrid format (with online learning accompanied by face-to-face instruction) or in a traditional format. They found no difference between the two groups on course pass rates, final exam scores, or performance on a standardized assessment of statistical literacy. Similarly, after comparing the learning of clinical skills in undergraduate nurse education between the online format and the traditional format, McCutcheon et al. (2015) arrived at the same conclusion: There was no difference between the two formats.

However, a large number of studies found statistically significant, positive associations between online or hybrid format and student learning outcomes and/or perceptions (e.g., Harmon & Lambrinos, 2006; Means et al., 2010; Navarro & Shoemaker, 2000; Nguyen, 2015; Rovai & Jordan, 2004). In their meta-analysis, Means et al. (2010) selected studies that utilized a rigorous research design and analyzed 45 studies, most of which were conducted in higher education settings. They found that students in an online format performed modestly better, on average, than those learning the same material through face-to-face instruction; further, compared with exclusively online learning, blended learning (i.e., instruction combining online and face-to-face elements) had a larger advantage relative to purely face-to-face instruction. Years later, Nguyen (2015)

conducted an in-depth review of the existing evidence and concluded that "Taken as a whole, there is robust evidence to suggest online learning is generally at least as effective as the traditional format" (p. 309). For example, using a sample of undergraduates taking an introductory economics course at a public university, Harmon and Lambrinos (2006) discovered that after correcting for sample selection bias, average test score for the online format students was higher than that for the traditional format.

Meanwhile, a small number of studies detected statistically significant, negative effects or mixed effects of online learning (Nguyen, 2015). A recent meta-analysis (Lack, 2013) used similar criteria as Means et al. (2010) in selecting studies to review, but added a criterion—a study had to include undergraduates in for-credit course(s). Lack's review included an additional 30 studies and her findings were mixed: Some researchers found that students in the online or hybrid format performed better than those in the traditional format, while some found the opposite; no difference was found in other studies. Lack therefore concluded that, based on these studies, there was no sufficient evidence for determining whether online learning is more or less effective than the traditional format.

More recent research also yielded mixed evidence. For example, Jesus et al. (2017) compared pharmacy undergraduates' performance between face-to-face and blended learning approaches in a therapeutics course. T-tests revealed that the blended learning group achieved higher scores. Bettinger et al. (2017) found that the average grade of undergraduates taking an online course was lower relative to those taking an in-person course which taught the same content. Yen et al. (2018) compared face-to-face, online, and blended modalities in an undergraduate course. However, their results indicate that students performed equally well academically (as measured by three course examinations, one research paper, and the overall course grade); no difference was found on student satisfaction with their learning experiences.

In summary, prior to the pandemic, empirical evidence on the link between course modality and student learning outcomes and perceptions appears to be inconclusive. One of the reasons for such inconsistency could be the use of varied methods. Nguyen (2015) pointed out that the majority of studies and meta-analyses did not account for self-selection bias.

Research on Impacts of Course Modality on Student Experience During the Pandemic

Limited research conducted during the pandemic suggests significant differences in student perceptions and academic achievement by course modality, with students in online classes responding less positively and having lower academic achievement. However, taken as a whole, evidence seems to be somewhat inconclusive.

Bird et al. (2022) studied the impact of the shift from in-person to online instruction in spring 2020 on the academic performance of Virginia's community college students and found modest negative impacts on course completion. Price Banks and Vergez (2022)

surveyed students who took courses at City University of New York in spring 2020. Their study also focused on students' experiences with transitioning from in-person to online instruction. They observed that students rated in-person courses more positively than online courses, and there was a weak yet positive relationship between perceptions of online learning and academic achievement. One limitation of their study is that they included both undergraduate and graduate students, overlooking the potential differences between these two populations. Kofoed et al. (2021) randomly assigned 551 West Point students to an online or in-person introductory economics class during the fall 2020 semester; based on their analysis, students in online courses underperformed their peers in in-person courses in terms of final course grade. Also using a sample of undergraduates at a public university, Altindag et al. (2023) reached similar conclusions. Based on combined data of four semesters (fall 2020 to spring 2022), they found that undergraduates enrolled in face-to-face courses were more likely to pass a course than those enrolled in online courses and also outperformed the latter on final course grade.

With respect to student satisfaction, Wright et al. (2023) found a similar pattern; they compared undergraduates who participated in classes that met in person at least once a week and those who never or rarely participated in an in-person class during spring 2021, and found that the former reported higher overall levels of academic satisfaction than the latter. One limitation of their study is that it was not a precise comparison between the online and in-person course modality, as "classes that met in person at least once a week" could cover a wide spectrum.

Keith (2022) produced mixed evidence: She examined the impact of first-year seminar (FYS) course modality on first-semester grade point average (GPA) of community college students in the fall 2021 and spring 2022 semesters. In terms of first-semester GPA, she found no difference between full-time students by course modality (face-to-face, hybrid, and online); however, part-time students in the face-to-face FYS outperformed the other two groups.

The small number and limitations of the studies summarized above suggest that there are knowledge gaps with regard to the relationship between course modality and student perceptions and academic outcomes during the pandemic. Only one of the studies (Keith, 2022) included the blended learning/hybrid model; none included students from liberal arts colleges. In terms of dependent variables, these studies mostly measured student satisfaction within individual course(s) and academic outcomes by course-level performance (course completion rate, course grade, or objective test/exam results with a course); a few compared semester GPA.

This study attempts to fill the gaps and contribute to an expanded understanding of the net effects of course modality on student satisfaction and academic outcomes at liberal arts colleges. Using both student self-reports and objective academic records, I compared three course modalities: online classes, blended learning, and in-person classes while controlling for background variables. This study aims to measure not only student satisfaction with key aspects of academic experience, but also their academic

outcomes beyond individual courses. Further, I examined whether course modality interacts with gender and whether online or blended learning poses a particular challenge to certain subgroups.

Method

The study used data collected from undergraduates at a selective, highly residential, private liberal arts college located in a suburban setting in the mid-Atlantic area—Mid-Atlantic College (a fictitious name; hereafter the *College*)—during the pandemic. The *College* has consistently been ranked by the *US News & World Report* as one of the best liberal arts colleges in the nation. Prior to March 2020 (when the *College* had to switch to remote instruction with the onset of the pandemic outbreak), it had never offered online classes except for a handful of recently launched summer online courses enrolling less than 100 students. During the 2020–21 academic year, the *College* de-densified its campus. For the spring 2021 semester, it invited upper-class students to live on-campus and required first-year students to take classes remotely from home, but with exceptions granted for legitimate reasons. While most upper-class students returned to campus, some chose to take classes remotely; among first-year students, most were remote learners, but some were approved to live on campus.

In this study, I examined student satisfaction and academic outcomes by a student's predominant course modality in the spring 2021 semester and attempted to answer the following research questions:

1. Is there a significant association between course modality and any of the following student demographic characteristics: gender, race/ethnicity, class level, Pell status, and first-generation status?
2. Does student satisfaction with academic experiences differ by course modality after controlling for gender, race/ethnicity, class level, Pell status, and first-generation status?
3. Do student academic outcomes differ by course modality after controlling for gender, race/ethnicity, class level, Pell status, first-generation status, and other relevant variables?
4. Does course modality interact with gender in affecting student satisfaction and academic outcomes after controlling for race/ethnicity, class level, Pell status, first-generation status, and other relevant variables?
5. Does the relationship between student satisfaction and academic outcomes differ by course modality?

Data Sources, Variables, and Sample

Results from this study were primarily based on data from two sources: (a) student self-reports on a Student Experience Survey (hereafter the Survey) administered online

at the *College* from mid- to late March 2021 (response rate: 34%); and (b) official institutional records, including student demographic data (gender, race/ethnicity, class level, Pell status, first-generation status, whether a student was a music major/minor) and academic achievement data for the spring 2021 semester downloaded from the *College*'s administrative database.

Almost all of the Survey questions were developed in-house by the Office of Institutional Research in consultation with a student success taskforce. The population file for the Survey was provided by the Office of Residential Life and specified during that semester which students were taking classes remotely from home (Remote Cohort; classes were taught synchronously), and which students were studying on campus (Residential Cohort). All students in the Remote Cohort and Residential Cohort were invited to take the Survey. The Residential Cohort was comprised of students who were living on campus (the great majority) or in college-leased hotels (for temporary de-densification purpose); these hotels were within walking distance to the campus and the *College* provided shuttles to and from the campus. Also included in the Residential Cohort were 29 students living off-campus in the local community with the approval of the *College*. All students in the Residential Cohort were permitted to take in-person classes and had access to campus resources and facilities.

The Survey included a question (adopted from the Higher Education Data Sharing Consortium or HEDS Fall 2020 COVID-19 Survey) which was only for the Residential Cohort: *Which of the following best describes how your classes are being taught this semester*? (Select one). Response options included: A (*Entirely face-to-face*), B (*Primarily face-to-face with occasional online interactions*), C (*A roughly even blend of face-to-face and online interactions*), D (*Mostly online with occasional face-to-face interactions*), and E (*Entirely online*).

After downloading the Survey dataset, I created a variable, *CourseModality*, under which there are three values: students who selected response option A or B were coded as the "Residential In-Person-Class Group"; those who selected response option C were coded as the "Residential Blended Learning Group"; and respondents who were in the Remote Cohort as well as those who selected response option D or E were all coded as the "Online-Class Group" (classes were taught synchronously). These three groups represented three course modalities: face-to-face, hybrid/blended, and online, respectively. Based on the variable *CourseModality*, I then created a derived variable, named *CourseModality4*, which has four values, corresponding to four groups: Residential In-Person-Class Group, Residential Blended Learning Group, Residential-But-Online-Class Group (i.e., students who selected response option D or E), and Remote Cohort; in other words, under variable *CourseModality4*, the "Online-Class Group" was disaggregated into two subgroups. For Research Question 1, in order to get a nuanced understanding of the respondent profile, I compared four groups of students as defined by the variable *CourseModality4*. Unless otherwise stated, all results for the remaining research questions were based on analysis using the variable *CourseModality* (comparing three groups).

I used a student's course modality as the primary independent variable; five demographic variables (gender, race/ethnicity, class level, Pell status, first-generation status) and four interaction variables (Course Modality × Gender; Gender × Race/Ethnicity; Gender × Class Level; Race/Ethnicity × Class Level) were additional independent variables used as control variables for all but two dependent variables. A student's Pell status and first-generation status were used as measures of socioeconomic status. For the purpose of this study, a first-generation college student was defined as one from a family where neither parent (nor guardian) held a bachelor's degree or higher.

Dependent variables included student experience and outcome variables. Experience variables covered two dimensions of student experience during the spring 2021 semester: self-reported levels of satisfaction with three key aspects of academic experience, and sense of connection a student felt to the *College*. Data for the satisfaction variables were collected from the Survey question: *Overall, how satisfied are you with each of the following aspects of your experience at the College this spring?* Response options used a 4-point rating scale: 1 (*Very Dissatisfied*), 2 (*Generally Dissatisfied*), 3 (*Generally Satisfied*), 4 (*Very Satisfied*). The names of these three satisfaction variables were: CHALLENGE (Satisfaction with Level of Academic Challenge), TEACHING (Satisfaction with Quality of Teaching), and OVERALLQUALITY (Satisfaction with Overall Quality of Academic Experiences). Data for sense of connection was collected from the Survey question: *How connected do you feel to the College?* Response options also used a 4-point rating scale: 4 (*Very strong connection*), 3 (*Strong connection*), 2 (*Some connection*), 1 (*Very little or no connection*). This variable was named CONNECTION. Two outcome variables measured academic achievement/performance during the spring 2021 semester: (1) number of course units a student passed (variable name: PASSEDCOURSEUNITS; i.e., course units for which a student received either a non-F letter grade or Satisfactory grade) and (2) a student's GPA (variable name: GPA), both of which are continuous variables. All students at the *College* are required to pass a minimum of 32 course units in order to graduate, except for those pursuing a music major who are required to pass 36 course units. Music majors, and oftentimes music minors, tend to pass more course units per semester than others. For this reason, whether a student had declared a major/minor in music at the time of the Survey was used as an additional control variable (categorical variable with three values: Being a music major; Being a music minor; Neither) in the model for the dependent variable: number of course units passed. Lastly, the number of course units a student passed toward GPA (i.e., passed with a letter grade) for that semester was used as an additional control variable (continuous variable) in the model for the dependent variable: GPA.

The preliminary sample included 33 international students, all of whom were excluded from the final sample, as some were living in their home country for pandemic-related reasons and time zone difference represented a unique challenge, making their experience not comparable to those of domestic students. Additionally, residential students who switched to remote learning at any point during that semester were deleted (as they experienced two course modalities). Part-time students, commuter students, and

American Indian/Alaska Native students were removed as well, given their small number. The final sample included 729 students: 481 (65.98%) were in the Online-Class Group (including 250 or 34.29% in the Remote Cohort, and 231 or 31.69% in the Residential-But-Online-Class Group); 172 (23.59%) were in the Residential Blended Learning Group; and 76 (10.43%) were in the Residential In-Person-Class Group. Furthermore, 428 (58.71%) were women, while 33 (4.53%) were Asian, 33 (4.53%) were African American/Black, 75 (10.29%) were Hispanic/Latino, 12 (1.65%) were students of two or more races, and 576 (79.01%) were White. In terms of socioeconomic status, 168 (23.05%) were Pell recipients; 152 (20.85%) were first-generation students.

Methods of Data Analysis

To answer Research Question 1, I conducted chi-square tests (and also *post hoc* tests, when a chi-square test was significant, as course modality has more than two levels). To answer Research Questions 2, 3 and 4, I performed general linear model (GLM) procedures (PROC GLM) using the Statistical Analysis System (SAS) software. PROC GLM "handles models relating one or several continuous dependent variables to one or several independent variables. The independent variables can be either *classification* variables, which divide the observations into discrete groups, or *continuous* variables" (SAS Institute Inc., 2017). In this study, all of the six dependent variables are continuous variables. For five of them, the model used classification/categorical variables as independent variables. The model for the dependent variable, GPA, used both classification/categorical variables and a continuous variable as independent variables. Therefore, it is appropriate to use SAS PROC GLM for Research Questions 2, 3, and 4. Based on the PROC GLM results, if the overall *F* test for the model was significant, I then examined the individual tests for each effect (Type III sums of squares hypothesis tests). If a significant interaction effect was found, follow-up analyses (i.e., tests of simple effects) were performed to identify significant subgroup differences. SAS LSMEANS (Least Squares Means)—part of the GLM Procedure—was used to perform multiple comparisons (of least squares means) on interactions as well as on main effects. All pairwise differences in terms of least square means were analyzed to identify significant group differences, with a multiple comparison adjustment for the *p*-values (i.e., multi-testing corrections; ADJUST=TUKEY option was specified given the data were unbalanced; SAS Institute Inc., 2017). For Research Question 3, if a significant main effect on GPA was found for the number of course units passed toward GPA, SAS PROC CORR was run to identify the direction and magnitude of the correlation. To answer Research Question 5, SAS PROC CORR was conducted for each of the three groups of students, testing the correlation between each satisfaction variable and each academic outcome variable. For all significance tests, the alpha level was set at 0.05.

Prior to the final analysis, statistical assumptions for using PROC GLM were checked by examining model diagnostics. Plots of the residuals versus the predicted values were examined for each dependent variable; the residuals seemed to be randomly scattered,

indicating constant variance. However, for the number of course units passed and GPA (to a lesser degree), the distributions of residuals (Q-Q plots and histograms of residuals) exhibited some deviation from normality—data were skewed (heavy tails on the left or too many extremely low values than would be expected). To address this problem, I took the following remedying steps.

First, all students who passed less than two course units during that semester (n = 9), and all those who took at least one letter-grading course but whose GPA was lower than 2.00 for that semester (n = 12), were manually verified by checking the *College*'s administrative database. These outliers were correct, official institutional records and seemed to represent natural variations in the target population.

Next, I ran PROC GLM both with and without outliers and compared results. For the number of course units passed, when five students (among those nine) with the least course units passed were included, course modality interacted with gender, p = .018. After excluding them, the normality of residuals noticeably improved; the overall model was a better fit—R-Square increased from 0.25 to 0.29; the interaction between course modality and gender was approaching statistical significance, p = 0.057. I also performed square root transformation on this dependent variable (without removing these five outliers), which slightly improved the normality of residuals. After the transformation, the interaction, course modality × gender, was significant (p = .030), but R-Square dropped substantially to 0.16. Based on analysis with or without these five outliers, no subgroup difference by course modality and gender was significant. The profile of these five outliers showed variation in course modality and demographic characteristics and did not appear to be systematically different from the rest of the sample. These five outliers were included in the final analysis related to this dependent variable.

Regarding GPA, of those 12 students mentioned above, five with the lowest GPA were recoded as having missing values or having a certain GPA had they used the S/U option. The recoding of these five outliers led to considerable improvement in the normality of residuals (although the R-Square dropped from 0.23 to 0.20). I also performed square root transformation on GPA (without recoding those five outliers), which somewhat improved the normality of residuals; however, the R-Square dropped to 0.10. Neither the recoding nor the square root transformation affected the significance of the overall model or course modality. These five outliers varied in course modality; however, their profile did not mirror the sample in terms of gender. These five outliers were excluded from the final analysis related to this dependent variable.

Limitations

This study drew upon data collected from a single institution. Therefore, caution should be taken in generalizing the findings to other liberal arts colleges or other types of institutions. It was conducted during the pandemic; thus student perceptions and outcomes might have been influenced by factors unique to that period (e.g., taking

classes online while living on campus; being infected with the virus), which limits the generalizability of findings to the postpandemic era. Also, to determine their predominant course modality of residential students, this study relied on their self-report instead of objective criteria (as institutional records on the modality of each course were not available). Additionally, the modest violation of the assumption of normality of residuals may potentially weaken the results on one dependent variable: number of course units a student passed. Another limitation is that despite the moderate size of the overall sample, for certain interaction variables, the number of students in some subgroups was very small (<10), which may lead to less power for detecting statistical significance of interaction effects of control variables and subgroup differences (Wang & Ware, 2013).

Lastly, during the 2020–21 academic year, the *College* permitted all students to convert any of their courses in fall 2020 or spring 2021 to S/U grading (policy during normal times: limit of two S/U courses in any one year). However, courses taken as S/U for spring 2021 would still count against the maximum of six courses on an S/U basis allowed over a student's academic career. All grades of C– or better in a course for which a student elected S/U would convert to S; all grades of D+ or below, to U. Courses graded S or U were not used in calculating a student's GPA. The deadline for students to select which course(s) to convert to S/U was three days after the letter grades were due from instructors (i.e., late May 2021). For spring 2021, in the final sample, course units passed with an S grade constituted 6.99% of all the course units passed (average number of course units a student passed: 3.96; average number of course units a student passed with an S grade: 0.28); 158 students (21.67%) passed 0.25 or more course units with an S grade. According to the *College*'s registrar, both percentages more than doubled those for a typical semester. In the final sample, 46 students (6.31%) received one or more U grades, a percentage larger than that for a typical semester. Therefore, the GPA measure under study did not reflect the variation of student academic performance with as much granularity as in a normal semester and the expanded S/U grading option might have masked the poor performance of some students. This may limit the generalizability as well. Recognizing the potential confounding effects of the expanded S/U grading option, I used the number of course units a student passed with a letter grade as a covariate in the model for GPA; still, it is impossible to determine whether this statistical control is adequate.

Results

Significant Differences on Select Demographic Characteristics by Course Modality

There was a significant association between course modality (*CourseModality4*) and class level, $\chi^2(9, N = 729) = 133.06$, $p < .001$, and between course modality

(*CourseModality4*) and Pell status, $\chi^2(3, N = 729) = 11.08$, $p = .011$. In the Remote Cohort, the observed percentage of first-year students was significantly higher than the expected percentage under the null hypothesis (i.e., there was no relationship between course modality and class level); the observed percentage of first-year students in each of the remaining three groups (Residential In-Person-Class Group, Residential Blended Learning Group, Residential-But-Online-Class Group) was significantly lower than expected. In the Remote Cohort, the observed percentage of both sophomores and seniors was significantly lower than expected. In the Residential In-Person-Class Group, there was a higher-than-expected percentage of seniors. Additionally, in the Remote Cohort, the observed percentage of Pell recipients was significantly higher than expected (see Table 1).

Table 1. Cross-Tabulations by Course Modality and Select Demographic Characteristics and Results from Chi-Square Tests (N =729)

Characteristic	Percent				Sig. Difference	
	Remote Group (n = 250)	Residential-But-Online-Class Group (n = 231)[b]	Residential Blended Learning Group (n = 172)	Residential In-Person-Class Group (n = 76)[c]	χ^2	p
Gender					2.99	.394
Men	37.60	41.99	45.93	40.79		
Women	62.40	58.01	54.07	59.21		
Race/Ethnicity[a]					17.35	.137
Asian	6.00	3.90	4.07	2.63		
Black or African American	7.20	2.60	4.07	2.63		
Hispanic/Latino	13.20	9.09	9.88	5.26		
Two or more races	2.00	0.87	1.74	2.63		
White	71.60	83.55	80.23	86.84		
Class Level					133.06	<.001
First-year	50.00	17.32	14.53	3.95		
Sophomore	17.20	29.87	25.58	23.68		
Junior	19.60	28.57	27.91	22.37		
Senior	13.20	24.24	31.98	50.00		

Characteristic	Percent				Sig. Difference	
	Remote Group (n = 250)	Residential-But-Online-Class Group (n = 231)[b]	Residential Blended Learning Group (n = 172)	Residential In-Person-Class Group (n = 76)[c]	χ^2	p
Pell Status					11.08	.011
Pell recipients	30.00	17.75	20.93	21.05		
Not Pell recipients	70.00	82.25	79.07	78.95		
First-generation Status					4.60	.204
First-generation students	24.40	17.75	22.09	15.79		
Non-first-generation students	75.60	82.25	77.91	84.21		

[a] The number of students in some subgroups was very small (<10). Eighteen respondents in the final sample originally did not specify their race/ethnicity. Five of them were recoded as belonging to a specific racial/ethnic group based on their self-report on the Cooperative Institutional Research Program (CIRP) Freshman Survey (administered to new first-year students during their first week of classes) or the HEDS Graduating Senior Survey (administered during the spring of graduation). The remaining 13 did not take either survey and were recoded as White based on the pattern revealed through previous research conducted at the College and by other scholars.

[b] Consisted of 167 students (22.91%) who described their classes as "Mostly online with occasional face-to-face interactions," and 64 students (8.78%) who described their classes as "Entirely online."

[c] Comprised of 71 students (9.74%) who described their classes as "Primarily face-to-face with occasional online interactions," and 5 students (0.69%) who described their classes as "Entirely face-to-face."

$^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

Significant Differences on Satisfaction and Sense of Connection by Course Modality

The overall model of the 10 independent variables explained a significant proportion of the variance in each of the three satisfaction variables, and in sense of connection a student felt to the *College*. At the individual predictor level, course modality (*Course-Modality*) produced significant main effects on four dependent variables: satisfaction with level of academic challenge, $F(2, 693) = 7.39$, $p < .001$; satisfaction with quality

of teaching, $F(2, 693) = 11.72$, $p < .001$; satisfaction with overall quality of academic experiences, $F(2, 692) = 24.98$, $p < .001$; and sense of connection a student felt to the *College*, $F(2, 686) = 17.42$, $p < .001$. On each of the three satisfaction variables, the Online-Class Group reported the lowest level of satisfaction among the three groups; this group also reported the weakest sense of connection to the *College* among the three groups. Additionally, on quality of teaching, the Residential Blended Learning Group reported lower satisfaction than the Residential In-Person-Class Group.

To provide a more nuanced understanding of sense of connection a student felt to the *College*, I also conducted follow-up analysis to uncover potential differences between the two subgroups within the Online-Class Group: the Remote Cohort and the Residential-But-Online-Class Group. Using the variable *CourseModality4*, the overall model of the 10 independent variables also explained a significant proportion of the variance in this dependent variable, a proportion lager than that explained by the model when the variable *CourseModality* was used (R-Square = 0.16, as compared to 0.11); *CourseModality4* yielded a significant main effect, $F(3, 684) = 25.46$, $p < .001$, with the Remote Cohort reporting the weakest sense of connection among the four groups; the Residential-But-Online-Class Group reported a weaker sense of connection than the Residential In-Person Group; however, the difference failed to meet the statistical significance threshold ($p < .05$)—it was approaching statistical significance, $p = .057$.

Significant Differences on Academic Outcomes by Course Modality

The overall model of the 11 independent variables explained a significant proportion of the variance in the number of course units passed during that semester and semester GPA. At the individual predictor level, course modality (*CourseModality*) interacted with gender in its effect on the number of course units passed, $F(2, 693) = 4.05$, $p = .018$; however, no subgroup difference by course modality and gender was significant after p value was adjusted for multiple comparisons. The main effect of course modality on semester GPA was not significant, $F(2, 684) = 2.45$, $p = .087$; nor was the interaction (Course Modality × Gender), $F(2, 684) = 0.02$, $p = .976$. See Table 2 for details.

Relationship Between Satisfaction and Academic Outcomes: Difference by Course Modality (*CourseModality*)

In the Online-Class Group, a positive albeit weak correlation was found between GPA and each of the three satisfaction variables (level of academic challenge, Pearson's $r = 0.15$, $p = .002$; satisfaction with quality of teaching, Pearson's $r = 0.12$, $p = .011$; satisfaction with overall quality of academic experiences, Pearson's $r = 0.24$, $p < .001$). Additionally, in the Online-Class Group, there was a weak, negative correlation between satisfaction with quality of teaching and the number of course units passed (Pearson's $r = -0.09$, $p = .046$). In the Residential In-Person-Class Group, there was a positive, moderate correlation between satisfaction with quality of teaching and

Table 2. F Values from GLM: Effects of Course Modality on Student Satisfaction, Sense of Connection, and Academic Outcomes

Independent Variable	CHALLENGE	TEACHING	OVERALLQUALITY	CONNECTION	PASSEDCOURSEUNITS	GPA
Primary						
Course Modality *(CourseModality)*	7.39***	11.72***	24.98***	17.42***	0.38	2.45
Control						
Gender	0.81	0.02	2.15	0.01	0.40	0.69
Race/Ethnicity	0.78	0.97	0.51	0.91	0.09	5.22***
Class Level	1.22	1.14	1.18	0.50	0.74	3.74*
Pell Status	0.76	0.26	1.04	0.00	0.13	2.30
First-Generation Status	0.26	0.65	0.27	0.40	0.34	6.84**
Course Modality × Gender	1.69	0.46	0.21	0.83	4.05*	0.02
Gender x Race/Ethnicity	0.26	1.11	0.67	2.36	2.04	3.27*
Gender × Class Level	0.51	0.15	0.37	0.65	6.13***	0.70
Race/Ethnicity × Class Level	1.32	1.63	1.01	1.36	1.83*	1.67
Additional Control Variables for Two Dependent Variables						
Music Major or Minor					72.53***	
Total Course Units Passed toward GPA						30.92***

(*continued*)

Table 2. F Values from GLM: Effects of Course Modality on Student Satisfaction, Sense of Connection, and Academic Outcomes (*continued*)

Independent Variable	CHALLENGE	TEACHING	OVERALLQUALITY	CONNECTION	PASSEDCOURSEUNITS	GPA
Overall Model Statistics						
Overall Model *F* Value	1.88**	1.92**	3.20***	2.62***	6.48***	5.15***
Overall Model R-Square	0.08	0.08	0.13	0.11	0.25	0.20

Note. Significant effects of the control variables: PASSEDCOURSEUNITS: Despite the interaction of Gender × Class Level, no subgroup difference was significant. White juniors passed more course units than both first-year Asian students and White seniors. Both Music majors and Music minors passed more course units than other students. GPA: Sophomores had a lower GPA than seniors. First-generation students underperformed non-first-generation students. White women, Asian men, women of two or more races, and White men outperformed African American/Black men; White women also outperformed Hispanic/Latino women and White men. There was a positive, albeit weak correlation between the number of course units passed toward GPA during that semester and semester GPA.

*$p < .05$. **$p < .01$. ***$p < .001$.

GPA (Pearson's $r = 0.39$, $p < .001$), and a positive albeit weak correlation between satisfaction with overall quality of academic experiences and GPA (Pearson's $r = 0.26$, $p = .021$). No significant correlation was found between satisfaction and academic outcomes in the Residential Blended Learning Group.

Discussion

This study sheds light on student experience during the pandemic and provides fresh insights on how course modalities affect student perceptions and academic outcomes, particularly at liberal arts colleges. It also contributes additional empirical evidence informing the continuing debate on the merit or effectiveness of online classes and blended learning.

Student Profile by Course Modality

The four groups by course modality were similar in terms of gender composition, racial/ethnic makeup, and first-generation student proportion. The disproportionate share of first-year students in the Remote Cohort was anticipated, given the fact that the *College* required first-year students to take classes remotely from home (although exceptions were granted for certain situations). In the Residential In-Person-Class Group, there was a disproportionate percentage of seniors, which was probably due to the necessity for some graduating seniors to take certain in-person classes (e.g., those with labs) in order to fulfil their remaining graduation requirements. The disproportionate number of Pell recipients in the Remote Cohort was perhaps related to financial factors. At the start of the 2020–21 academic year, the *College* announced a policy in response to the pandemic: full-time students studying remotely during fall 2020 or spring 2021 would receive a considerable amount of tuition credit. Coming from a low-income family, Pell recipients might be more motivated to take advantage of this incentive than others; by taking classes remotely, they could not only save money on tuition, but also on room and board.

Effects of Course Modality

I found that after controlling for gender, race/ethnicity, class level, and socioeconomic status, course modality has significant main effects on student satisfaction with all three key aspects of academic experience—level of academic challenge, quality of teaching, and overall quality of academic experiences. Indeed, among a host of predictor variables, course modality is the sole variable that produced a significant net effect; the online course modality compares unfavorably with both blended learning and the in-person course modality in terms of student satisfaction. Part of the Online-Class Group were students who chose to live on campus (thus did not receive the tuition credit) and yet their classes were mostly or entirely online; their

frustration and disappointment might have colored their perception. Meanwhile, it should be noted that other factors might have contributed to their lower satisfaction, e.g., internet connectivity issues.

One would expect that compared with the Residential In-Person-Class Group, the Residential Blended Learning Group would be less satisfied with all three aspects of academic experience. However, this occurred on a lone variable: satisfaction with quality of teaching. These two groups seem to have had similar perceptions regarding level of academic challenge and overall quality of academic experiences, and felt a similar sense of connection to the *College*. These findings suggest that, for the most part, blended learning seems to be able to deliver equally satisfying academic experiences as the traditional model. Regarding satisfaction with quality of teaching, the in-person model outperforms both the online and the blended learning models; this study clearly reaffirms the unbeatable strength of the traditional/in-person model at liberal arts colleges, which pride themselves on excellence in undergraduate teaching. This long-standing traditional model seems to have withstood the test of an unprecedented pandemic.

It comes as no surprise that the Online-Class Group, particularly the Remote Cohort, reported the weakest sense of connection to their college. Despite the *College*'s various virtual programs to connect with students taking classes online, they fell short in comparison with in-person interactions. This too reaffirms the unique appeal of course modalities with at least some face-to-face interactions embedded in them. This evidence also suggests that face-to-face interactions matter when building a sense of community on campus.

Given the significant differences by course modality on student satisfaction with academic experiences, one would expect academic outcomes to differ by course modality as well. However, after controlling for gender, race/ethnicity, class level, socioeconomic status, and relevant academic variables, I found that there is essentially no group difference on the number of course units passed, and these three groups seem to have performed similarly in terms of GPA. Course modality does not seem to have any apparent effect on these two objective measures of academic outcomes; online course modality and blended learning seem to perform just as well as the traditional course modality. It was likely that course instructors for online and hybrid classes developed effective pedagogies; perhaps academic support services, too, provided effective academic assistance. Besides affirming their apparent effectiveness, these findings attest to the resiliency of students whose classes were mostly or entirely online. Despite their less positive perceptions of academic experiences in the middle of the semester compared with peers in hybrid and in-person courses, they seemed able to adjust and finish strong. Perhaps the small class size (Mid-Atlantic College had an average class size of 18) and a low student to faculty ratio (10 to 1) of a selective liberal arts college, to some degree, helped reduce the otherwise negative effects of online/hybrid classes on student academic performance. Lastly, the absence of significant differences on GPA might be due to the expanded S/U grading option.

With respect to student perceptions, findings from this study are inconsistent with Yen et al. (2018) but consistent with Price Banks and Vergez (2022). In terms of academic outcomes, this study reaches the same conclusions as some researchers (Bernard et al., 2004; Keith, 2022; Nguyen, 2015; Yen et al., 2018), but contracts some others (e.g., Altindag et al., 2023; Bird et al., 2022; Kofoed et al., 2021). These inconsistencies could be attributed to the institutional type or the use (or not use) of control variables. It might also be related to the fact that in this study a student's course modality was based on multiple courses, not on a single course.

In the Online-Class Group, student perceptions of academic experiences were positively linked to GPA, consistent with Price Banks and Vergez (2022). This suggests that in online classes (although not in blended learning), student perceptions matter. It is therefore important to collect student feedback and address their dissatisfaction to promote academic success.

Implications for Practice and Directions for Future Research

Evidence from this study suggests that there is much room for improvement regarding student satisfaction with the quality of teaching in online classes. Skepticism about the quality of online classes will continue, given the less positive student perceptions revealed by this study and others. To maintain their distinct appeal in the marketplace, such as premiere undergraduate teaching and a close-knit community, a large-scale shift in course modality is unlikely to occur at residential liberal arts colleges in the foreseeable future. For those liberal arts colleges that currently offer or plan to offer some online courses, it is critical that they think very carefully about the number of online courses and provide pedagogical trainings.

Meanwhile, the fact that in this study academic outcomes are comparable across three course modalities indicate that online classes and blended learning (especially the latter) have real, noteworthy potential as an alternative modality for certain types of courses or small-scale programs (e.g., summer online courses) at residential liberal arts colleges postpandemic. The encouraging findings from this study provide some rationale for this type of institutions to explore or develop a limited number of special offerings through online or blended learning, expand their existing ones, or even explore the creation of an online or hybrid January term and/or summer session(s). These programs may be particularly attractive to students who desire more flexibility, face financial challenges or want to save money, lag behind in progress toward their degree, or plan to graduate early. With a cohort of faculty who seemed to have developed effective pedagogies for online and blended learning during the pandemic, liberal arts colleges can build upon this foundation and explore these nontraditional modes of course delivery. At least, the pandemic has presented this type of institution an opportunity to ask whether in-person classes are the optimal approaches to achieving certain learning outcomes, to consider the possibility of nontraditional course modalities to address students' diverse learning styles and needs, and to examine the trade-offs of online learning.

Implications from this study seem to echo a prepandemic case study (Einfeld, 2016) which also indicates the promise of online and blended learning at liberal arts colleges. Using qualitative data gathered from participant interviews, Einfeld (2016) examined how key stakeholder groups at a liberal arts college perceived the degree of compatibility between traditional liberal arts education and online learning. Each stakeholder group articulated ways in which online learning would undermine liberal arts education. However, there was also openness to online learning, in particular, incorporating a limited number of online courses. He observed:

> Faculty expressed optimism that hybrid formats could leverage the best of online and face to face formats in ways that could truly improve liberal arts education. By providing the right mix of experiences, instructors could take advantage of the unique opportunities in both online environments and face to face settings (p. ii).

Nowadays, student debt dominates much of the discourse in public scrutiny of the value of a college degree. Private liberal arts colleges tend to charge a higher tuition than other types of four-year institutions (IPEDS, 2023c; Mid-Atlantic College: about $55k tuition sticker price for the 2019–20 academic year). Financially speaking, offering online or hybrid courses, albeit to a limited degree, could potentially be one of the ways to enhance affordability at this type of institution.

Further research based on multiple liberal arts institutions is needed to provide additional evidence concerning the effects of course modality at this type of institution. However, opportunities may be very limited or even unavailable—some offer summer online classes, but in-person or hybrid classes are typically not offered simultaneously for comparisons. Additionally, future research could increase the power for detecting interaction effects and subgroup differences by using a larger and more balanced sample. Also, the student survey for this study was conducted in the middle of the semester. Future researchers should consider administering a student perception survey towards the end of a semester, so that students could provide overall ratings based on their entire semester experience. Lastly, qualitative research would be valuable to identify reasons for student dissatisfaction in online classes.

References

Altindag, D. T., Filiz, E. S., & Tekin, E. (2023). *Is online education working?* (Working Paper 29113). National Bureau of Economic Research. http://www.nber.org/papers/w29113

Bernard, R. M., Abrami, P. C., Lou, Y., Borokhovski, E., Wade, A., Wozney, L., Wallet, P. A., Fiset, M., & Huang, B. (2004). How does distance education compare with classroom instruction? A meta-analysis of the empirical literature.

Review of Educational Research, *74*(3), 379–439. https://doi.org/10.3102/00346543074003379

Bettinger, E. P., Fox, L., Loeb, S., & Taylor, E. S. (2017). Virtual classrooms: How online college courses affect student success. *The American Economic Review*, *107*(9), 2855–2875. https://doi.org/10.1257/aer.20151193

Bird, K. A., Castleman, B. L., & Lohner, G. (2022). *Negative impacts from the shift to online learning during the COVID-19 crisis: Evidence from a statewide community college system* (EdWorkingPaper, 20–299). Annenberg Institute at Brown University. https://doi.org/10.26300/gx68-rq13

Bowen, W. G., Lack, K. A., Chingos, M., & Nygren, T. I. (2012). *Interactive learning online at public universities: Evidence from randomized trials*. Ithaka S+R. https://doi.org/10.18665/sr.22464

Einfeld, A. M. B. (2016). *Liberal arts education and online learning: Practices, prospects, and limits* [Doctoral dissertation, Michigan State University]. Michigan State University Digital Repository. https://d.lib.msu.edu/etd/4046

Harmon, O. R., & Lambrinos, J. (2006). Online format vs. live mode of instruction: Do human capital differences or differences in returns to human capital explain the differences in outcomes? *Economics Working Papers*, 200607. https://opencommons.uconn.edu/econ_wpapers/200607

Integrated Postsecondary Education Data System. (2023a). *Distance education in IPEDS*. U.S. Department of Education, National Center for Education Statistics. https://nces.ed.gov/ipeds/use-the-data/distance-education-in-ipeds

Integrated Postsecondary Education Data System. (2023b). *12-month enrollment*. U.S. Department of Education, National Center for Education Statistics. https://nces.ed.gov/ipeds/use-the-data

Integrated Postsecondary Education Data System. (2023c). *Undergraduate charges*. U.S. Department of Education, National Center for Education Statistics. https://nces.ed.gov/ipeds/use-the-data

Jesus, A., Gomes, M. J., & Cruz, A. (2017). Blended versus face-to-face: Comparing student performance in a therapeutics class. *The Institution of Engineering and Technology*, *11*(3), 135–140. https://doi.org/10.1049/iet-sen.2016.0190

Keith, B. J. (2022). *The relationship of effects of first-year seminar course modality on community college student success* [Doctoral dissertation, Sam Houston State University]. Sam Houston State University Electronic Theses and Dissertations. https://shsu-ir.tdl.org/handle/20.500.11875/3830

Kofoed, M. S., Gebhart, L., Gilmore, D., & Moschitto. R. (2021). *Zooming to class?: Experimental evidence on college students' online learning during COVID-19* (Discussion Paper Series No. 14356). IZA Institute of Labor Economics. https://docs.iza.org/dp14356.pdf

Lack, K. A. (2013, March). *Current status of research on online learning in postsecondary education*. Ithaka S+R. https://doi.org/10.18665/sr.22463

McCutcheon, K., Lohan, M., Traynor, M., & Martin, D. (2015). A systematic review evaluating the impact of online or blended learning vs. face-to-face learning of clinical skills in undergraduate nurse education. *Journal of Advanced Nursing*, *71*(2), 255–270. https://doi.org/10.1111/jan.12509

Means, B., Toyama, Y., Murphy, R., Bakia, M., & Jones, K. (2010, September). *Evaluation of evidence-based practices in online learning: A meta-analysis and review of online learning studies* (Office of Planning, Evaluation, and Policy Development Monograph). U.S. Department of Education. Retrieved October 2022, from https://www2.ed.gov/rschstat/eval/tech/evidence-based-practices/finalreport.pdf

National Association of College and University Business Officers. (2022). *The 2022 NACUBO tuition discounting study*.

Navarro, P., & Shoemaker, J. (2000). Performance and perceptions of distance learners in cyberspace. *American Journal of Distance Education*, *14*(2), 15–35. https://doi.org/10.1080/08923640009527052

Nguyen, T. (2015). The effectiveness of online learning: Beyond no significant difference and future horizons. *MERLOT Journal of Online Learning and Teaching*, *11*(2), 309–319.

Price Banks, D., & Vergez, S. M. (2022). Online and in-person learning preferences during the COVID-19 pandemic among students attending the City University of New York. *Journal of Microbiology & Biology Education*, *23*(1), e00012–2D2. https://doi.org/10.1128/jmbe.00012-22

Rovai, A. P., & Jordan, H. (2004). Blended learning and sense of community: A comparative analysis with traditional and fully online graduate courses. *The International Review of Research in Open and Distance Learning*, *5*(2), 1–13. https://doi.org/10.19173/irrodl.v5i2.192

SAS Institute Inc. (2017). *SAS/STAT® 14.3 user's guide*. Retrieved 2022, from https://documentation.sas.com/doc/en/pgmsascdc/9.4_3.3/statug/statug_glm_details29.htm

Sewell, T. R. (2016). *Student outcomes in traditional, hybrid, and online courses in community college career and technical education programs* [Doctoral dissertation, East Tennessee State University]. East Tennessee State University Electronic Theses and Dissertations. https://dc.etsu.edu/etd/3101/

Thompson, V. L., & McDowell, Y. L. (2019). A case study comparing student experiences and success in an undergraduate mathematics course offered through online, blended, and face-to-face instruction. *International Journal of Education in Mathematics, Science and Technology*, *7*(2), 116–136.

Woltering, V., Herrler, A., Spitzer, K., & Spreckelsen, C. (2009). Blended-learning positively affects students' satisfaction and the role of the tutor in the problem-based learning process: Results of a mixed-method evaluation. *Advances in*

Health Sciences Education, *14*(5), 725–738. https://doi.org/10.1007/s10459-009-9154-6

Wang, R., & Ware, J. H. (2013). Detecting moderator effects using subgroup analyses. *Prevention Science*, *14*(2), 111–120. https://doi.org/10.1007/s11121-011-0221-x

Wright, G., Volodarsky, S., Hecht, S., & Saxe, L. (2023). Student satisfaction and the future of online learning in higher education: Lessons from a natural experiment. *Online Learning Journal*, *27*(1), 336–355. https://doi.org/10.24059/olj.v27i1.3224

Yen, S. C., Lo, Y., Lee, A., & Enriquez, J. (2018). Learning online, offline, and in-between: comparing student academic outcomes and course satisfaction in face-to-face, online, and blended teaching modalities. *Education and Information Technologies*, *23*(5), 2141–2153. https://doi.org/10.1007/s10639-018-9707-5

Zhao, Y., Lei, J., Yan, B., Lai, C., & Tan, S. (2005). What makes the difference? A practical analysis of research on the effectiveness of distance education. *Teachers College Record*, *107*(8), 1836–1884. https://doi.org/10.1111/j.1467-9620.2005.00544.x